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Electrical Journal

THE ELECTRICIAN:

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INDEX TO "THE ELECTRICIAN."

VOL. LXXX.

SPECIAL INDEXES.

* *Entries in these Indexes are* not *included in the* General Index.

SUB-HEADINGS IN GENERAL INDEX.

Names of Authors of Articles and Papers are indexed alphabetically in the General Index, *and not under the sub-headings.*

General Alphabetical Index.

***Heavy figures* denote that the subject matter is a "Leading Article" or in the "Editorial Notes." When the letter (C) is placed after a title it signifies that the article in question appeared in the Correspondence columns.**

Municipal, Foreign and General Notes.

Municipal, Foreign and General Notes.—*Continued.*

Companies' (Joint-Stock) Meetings, Reports, Dividends, Statutory Returns, &c.

Companies' (Joint-Stock) Meetings, Reports, Dividends, Statutory Returns, &c.—*Continued.*

Companies, Joint-Stock (New Electrical, &c.), Registered.

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE

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CONTENTS.

NOTES.

Electricity Direct from Coal Gas.

It is some years since any activity has been shown in the direction of devising carbon consuming cells, and, therefore, it is with some interest that we read the announcement of a patent by Mr. S. Albert Reed, of New York, which describes a cell for obtaining electricity direct from coal gas. This cell can scarcely be described accurately as one which consumes carbon, but probably the idea of the inventor is that if coal gas is used for rendering the cell active this is almost as good as using carbon itself. The cell described belongs to the class in which a fused electrolyte is employed (in this instance fused borax), and in this is dissolved the oxides of a metal, such as manganese, which easily forms two oxides differing in their degree of oxidation. If two solutions containing the higher and the lower oxide respectively are brought into contact, an E.M.F. is produced and it is this E.M.F. on which the cell is claimed to depend. Coal gas is introduced at one pole, and the oxide in the neighbourhood of this pole is thus maintained in a lower state of oxidation, whereas the oxide at the other pole is kept at a higher degree of oxidation. In considering a cell of this kind there is always the difficulty of [illegible]

[illegible]

junctions, but is subject to [illegible] inherent in this method of producing an E.M.F. [illegible] that the net result [illegible] 1 volt and an output of [illegible] surface (presumably [illegible]). This [illegible] the information given [illegible] omitting vital points, and [illegible] the true value of a cell of this kind. We [illegible] for further details.

Combination in Science.

In an interesting statement issued by Dr. M. E. Sadler, Vice-Chancellor of the University of Leeds, attention is drawn to the inter-working of the various departments of the University. As is well known, this University [illegible] of its departments, namely, those of the textile [illegible] industries being unique in [illegible]. Each of these departments has the good fortune to [illegible] and each has attached to it an advisory [illegible] industrialists are in the majority and [illegible] represented. Further, there are, of course, the [illegible] chemistry (which [illegible] of inorganic, organic, physical and agricultural chemistry), bio-chemistry and [illegible] as well as the departments of mechanical, civil, electrical and agricultural engineering and mining. [illegible]

[illegible]

[illegible]

a Scientific and Research Committee was added to assist the Industries Section of the Department of Mines and Industries in co-ordinating scientific and industrial research in South Africa, and to co-operate with other Government Departments in the United Kingdom and the Dominions. This is satisfactory evidence that the claims of scientific and industrial research are receiving official recognition in South Africa, another welcome announcement being that the Government is advertising for a technical adviser, at a salary commensurate with the importance of the position. What, however, we regard as the most valuable feature of the movements in South Africa, Australia, Canada and elsewhere is the general recognition that there must be co-operation between the United Kingdom and the Dominions in all these parallel developments in scientific and industrial research.

Aeronautical Institute of Great Britain.—We are informed that it was recently decided to classify members of the Institute as follows:

(I.) Members (M.Aer.Inst.), (II.) Associate Fellows and Fellows (A.F.Aer.Inst., F.Aer.Inst.), (III.) Honorary Fellows (Hon.F.Aer.Inst.) and (IV.) Associates (A.Aer.Inst.). The membership of the Institute is now nearly 1,000, and it is hoped to obtain 1,000 or more associates before the end of the year.

Kensington & Knightsbridge and Notting Hill Arbitration.—Mr. James Swinburne, F.R.S., has issued his award in the claim by the Kensington & Knightsbridge Electric Lighting Co. against the Notting Hill Electric Lighting Co. for damages for an alleged breach of agreement.

The arbitrator sat in July to hear evidence, and the facts are reported in The Electrician for July 20 last. The question was whether the taking of a supply of electrical energy in bulk from the Metropolitan Co. and Hammersmith Borough Council was a breach of an agreement made in 1900 with the Kensington Co.

Subject to appeal to the Court on the legal interpretation of the agreement and on points of law generally, the award of the arbitrator is entirely in favour of the Kensington & Knightsbridge Company.

The actual terms of the award will be given in our next issue.

Water Heated by Sunlight. In these days when everyone has the question of economy in fuel brought so strongly before their notice it is of interest to recall that in parts of California there are actually hot water systems operated by sunlight. For example, in the city of Monrovia it is stated that quite half the inhabitants make use of sun-heated water. The sun imparts its heat to water exposed in a copper coil on the roof of the house or other convenient position. As the temperature of the water in the coil rises a circulation is set up and the heated water rises through the coils to a storage tank, from which it is drawn for use. The Californian coast seems to be ideal for sunshine heaters, but there are probably many regions in the south of the United States where it might be practicable.

Artificial Daylight in Underground Passages.—The "Electrical World" contains an account of an interesting experiment in an underground tunnel connecting various sections of the National Electric Lamp Works. It was desired to remove the impression of being underground. Accordingly artificial windows were arranged at intervals along the sides of the tunnel, lit with lamps with special "daylight" blue bulbs being placed behind sheets of diffusing glass. The effect is said to resemble daylight quite closely both in colour and distribution of light. The illumination is distinctly uneven, but this is considered an advantage, as the windows tend to break up the monotony, and prevent the [illegible] appearance of a long underground passage which usually [illegible].

Cracking Hydrocarbon Vapours by Electrical Discharge.—According to the "Electrical World," a process is being developed in the United States for obtaining a greater yield of [illegible] from hydrocarbon vapours by subjecting them to [illegible] electrical discharge. The new process is covered by a patent (No. [illegible]) granted to Messrs. J. G. Davidson and R. W. Ford, of [illegible]. According to the inventors the amount of CH_4 in the gas has been increased from 25 to 40 per cent., and the amount of acetylene from 7-10 per cent. to 20-23 per cent. In general the gas is conducted through a series of vertical pipes, connected at their lower ends to a supply header, and at their upper ends to an outlet header, the discharge electrode being formed of wires hung axially in the pipes from an insulated support. The pipes are earthed and the electrode is connected to a mechanical rectifier of the rotary type included in the high tension circuit of a step-up transformer.

Reducing the Noise and Flash of Guns.—A contribution by Mr. N. Flamel to the "Scientific American Supplement" discusses the very interesting question of the suppression of flash and smoke from guns. Though it has been found possible to suppress smoke to a great extent by the use of powders that contain no mineral substances, it is extremely difficult to suppress both smoke and flash. It is stated that the Germans were the first to attempt to diminish flashes by adding to powders very small quantities of the alkalis or alkaline earth metals, such as the salts of calcium. But, unfortunately, immediately the flash is diminished the smoke begins to appear—*i.e.*, the sum total of flash and smoke tends to remain constant. Some alleviation may be secured by adapting the material to the conditions; for example, after nightfall the presence of smoke is of small moment, while the suppression of flash is all important. The complete solution of the problem would involve the suppression of sound as well as flash and smoke. Numerous devices, similar in principle to the silencer on a combustion engine, have been tried to reduce sound, and, it is said, have been successfully used on rifles; but they do not appear to have been found practicable with larger ordnance.

Fluorescence and Phosphorescence.—An interesting discussion on this subject has been raised by Dr. Sheppard in the "Illuminating Engineer." In a discussion on this subject before the Illuminating Engineering Society last year it was maintained by Mr. A. L. Landau that there is no real distinction between "fluorescence," which takes place only when the substance is stimulated by light, and "phosphorescence," which involves "after-glow." In any case, the term phosphorescence, according to this definition, could not be applied to phosphorus, the continuous glow of which is believed to be excited by a steady chemical change. Dr. Sheppard, however, contends that the two phenomena are essentially different. Fluorescence depends conjointly on chemical composition and the constitution of a saturated pure compound. Phosphorescence, on the other hand, depends on "the presence of stray or unsaturated affinities due to free, usually metallic, nuclei of several velency stages in colloidal or solid solution in the material." However, the origin of both phenomena is very obscure. It would appear that in this field there is room for much research, which may lead to important conclusions regarding the atomic and electronic changes responsible for the production of light.

Curve Plotting with Logarithmic Co-ordinates.—The advantages of logarithmic ruled section paper for plotting certain varieties of curves deserve to be more generally known. Any exponential equation of the general form $y=kx^n$ will be a straight line when y is plotted logarithmically and x arithmetically. This characteristic is particularly useful in plotting hyperbolae. Another advantage of logarithmic plotting is that we obtain uniform accuracy over the entire scale, in the same manner as on the slide rule. It is also claimed as an advantage of the method that a sudden change in the relation, giving a critical point on the graph will be more easily appreciated. Several instances occur in illuminating engineering where such methods are useful. One well known example is the plotting of curves of horizontal street illumination. The illumination midway between two lamps is in general a very small fraction of that near the light sources; if we are dealing with a single lamp the diminution in illumination is still more rapid. In most cases it is the region of the curve where the minimum occurs that is most important, and with an ordinary scale considerable differences at this part of the curve may be overlooked. The use of a logarithmic scale of intensity is in

this respect a distinct improvement. Yet another class of relations which may be conveniently plotted in this way are those representing the reaction of the eye to a wide range of illumination—*e.g.*, the effect on acuteness of vision and glare. We are here dealing with successive stages in the process of adaptation, operative over an enormously wide range of brightness, and it is very difficult to represent all these successive changes within a [illegible] compass without making use of a logarithmic scale [illegible].

Electric Canoes.—For a good many years electric launches were in use on the Thames to a considerable extent, but for one reason or another their popularity declined. According to our contemporary, "The Motor Ship and Motor Boat," the electric canoe is now rapidly growing in popularity on the upper Thames, though precisely what has brought about this change of opinion is not stated. Possibly the petrol situation may have something to do with it. It is pointed out that the great advantage of the electric canoe is that it is very quiet in its running, and causes no annoyance to other users of the river. Particulars are given of some of the craft now in use. Those built at Maidenhead are about 30 ft. in length, and are equipped with E.P.S. batteries of 50 cells, rated at 200 ampere-hours. When running at full speed the current consumption is stated to be about 38 amperes at approximately 100 volts, and the average speed attained up and down stream is 11 miles per hour. An average of 6 miles per hour is attained by connecting the two halves of the battery in parallel. Under ordinary conditions the battery capacity is sufficient for running about six hours. The battery is generally placed in a central position, along with a motor, and does not interfere materially with the accommodation. Most of the canoes in service are equipped with batteries of only 30 cells. It is stated that the positive plates last for four years, and negative plates [illegible] eight years. Charging can occasionally be effected direct from a town supply, but frequently a motor-generator is desi[illegible]. The regular price charged by boat builders to boat owners appears to be at the rate of 1s. per unit, which, as our contemporary remarks, "should leave a fair margin of profit." It sounds to us as though that price dated from many years ago, but we presume that the boating fraternity does not inquire into such matters.

Electricity Direct from Coal Gas.—The "Electrical World" reports that Mr. S. Albert Reed, of New York (in patent No. 1,2[illegible]) discloses an electrolytic cell which conduces substantially to the production of electricity direct from coal gas. The principle of the method is to dissolve in an electrolyte [illegible] the oxide of a metal, such as manganese, which forms [illegible] two or more oxides of different degrees of oxidation and readily passing from a lower to a higher degree of oxidation when in contact with air and from a higher to a lower when in contact with a reducing agent, such as fuel gas. When the solutions of a higher and a lower oxide are brought into liquid contact at any point a difference of electrical potential results, and if an appropriate electrode is immersed in each of the solutions a current of electricity will pass in a [illegible] then, so long as the difference of oxidation in the two solutions respectively is maintained. The current obtained when the electrodes are of platinum and the metallic oxide [illegible] oxide of manganese is approximately 1 volt and [illegible] from [illegible] amp. per sq. foot of active surface and upwards. In a heated chamber is placed a shallow dish [illegible] earthenware, within which there is contained a [illegible] of similar material forming a reduction [illegible]. A tube for supplying fuel gas [illegible] into the inner chamber and vent holes are provided for the products of combustion. The electrodes are placed in the [illegible] and outer portions of the [illegible] containing the [illegible] of manganese [illegible]. So long as fuel gas is supplied [illegible] the difference of oxidation of the two oxides is maintained and a current [illegible] through the [illegible]. The oxygen which [illegible] the fuel is stated to be [illegible] supplied [illegible] from the air taken up at [illegible] extended surface [illegible] present [illegible] heated chamber.

Annual Report of the Am.I.E.E. Committee on Transmission and Distribution.—The annual report [illegible] Committee on Transmission and Distribution, now [illegible] the "P[illegible] Engineers, refers specially to high-tensi[illegible] underground cables. These are the two s[illegible] for special attention as a result of a circu[illegible] 23 members of the Committee asking for su[illegible] urgent problems in transmission and dis[illegible] the last few years troubles with high-tens[illegible] been cumulative, and in the seasons of [illegible] failure of insulators on some long-d[illegible] caused very troublesome interrupt[illegible] Pacific coast. [illegible] in progress, and it has been dealt with in several [illegible] the Institute. So far as porcelain insulators are con[illegible] it appears (1) that porosity must be reduced to the [illegible] practical limit to prevent absorption, (2) that joints [illegible] so arranged that the insulators will not crack f[illegible] and contraction effects, and (3) that insulators mus[illegible] margin of mechanical strength. In regard to underground cables, importance is attached to the disposing of heat due to copper and other losses. Conduit lines were designed 15 or more years ago, with the idea that there would be 3–5 watts lost per foot of cable. It is now recognised that the dissipation of this heat must receive attention, and that the conduits need to be very carefully designed. The avoidance of prejudicial heating may be effected by conducting away the [illegible] by appropriate means and by restricting the amo[illegible]. The latter is largely a problem for the cable manufa[illegible]. Attention is drawn to the use of certain insulating ma[illegible] such as saturated pa[illegible] hysteresis losses. These losses are by no means [illegible] and are sufficient in some cases to cause cable rati[illegible] than doubled. The question [illegible] dealt with in a Paper [illegible] Mr. [illegible]. Roper has dealt with the important problem of the [illegible] high-tension cable [illegible] breakdown. Finally, it is suggested that further information would be [illegible].

OBITUARY.

[illegible]

PERSONAL.

[illegible]

THE COMMUTATION OF LARGE CONTINUOUS CURRENT GENERATORS AND ROTARY CONVERTERS UNDER HEAVY OVERLOAD CONDITIONS.*

BY [illegible] BELL.

Summary.—The author describes a device, due to Prof. [illegible] Walker, enabling a continuous-current generator or rotary converter having commutating poles to be heavily overloaded without sparking. The commutating poles do not require to be carefully adjusted as in an ordinary machine, and on overload the commutating pole is automatically strengthened to the requisite extent.

Modern continuous generators and rotary converters are generally fitted with commutating poles, or, as they are frequently termed, interpoles. With the usual arrangement of the interpoles, at very heavy loads they fail to do their duty owing to the saturation of the iron, and bad sparking results. Especially is this the case when continuous-current generators or rotary converters are used to supply a traction system. These machines will carry many times their full load current for a few seconds without over-heating, and it is desirable that they should be built to take these extra heavy overloads without flashing-over at the commutator. This Paper describes some experiments which have been made with an arrangement† devised by Prof. Miles Walker for obtaining good commutation up to much heavier loads than has hitherto been possible, notwithstanding the saturation of the interpoles.

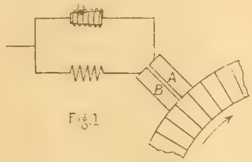


Fig.1

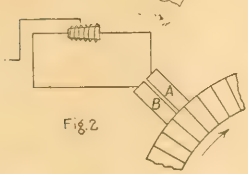


Fig.2

Where the inductance of the armature coil is low, and the current to be commutated is small, the commutation can be carried out successfully by the resistance of the carbon brush, but in machines of higher rating it is advisable to assist the reversal of the current by a commutating E.M.F. This E.M.F. should operate upon the coils during the period in which they are short-circuited by the brush. It can be provided by an auxiliary pole, placed near the neutral axis. Now, the magnetomotive force of the armature will tend to magnetise the pole in the wrong direction. Hence we must provide upon the commutating pole sufficient ampere-turns to overcome the armature ampere-turns, and to produce a flux of the amount desired.

Since we have large numbers of ampere-turns (on armature and interpoles) opposing each other, the leakage is very great, and on heavy loads this causes saturation of the pole. The resultant number of ampere-turns upon the pole is small, so this saturation causes considerable weakening of the flux. Thus, in order to obtain a commutating field which is proportional to the load, the [illegible] of the interpole must increase at a greater rate than the load current.

The author then proceeds to consider what happens in an armature [illegible] commutation. He discusses cases in which the reactance [illegible] small compared with the resistance [illegible] conditions within the coil as it [illegible]

[illegible] it is shown that when there [illegible] field is too weak, [illegible] a large pro[illegible] by the trailing portion [illegible] that the persisting [illegible] current on the [illegible] trailing portion [illegible] described below [illegible] connection [illegible] point upon the [illegible] From [illegible] commutating pole winding, which is made with more turns than ordinarily, say twice as many. Brush B is connected to a resistance, which in this Paper is referred to as the diverter. The outside of this diverter joins the main circuit outside the commutating poles. If the resistance of the diverter be made equal to that of the commutating pole each brush will normally collect one-half of the current, and therefore since the interpole has twice as many turns as in the ordinary machine, using a single brush we will obtain normal excitation from it.

Suppose now that upon heavy overload the pole becomes saturated, so that the flux does not increase as rapidly as the exciting current. The interpole will be too weak for that particular load, and the reversal of the current will be delayed. The effect of this will be, as shown above, to increase the amount of current collected by the trailing brush. This automatically strengthens the interpole and so tends to reduce the inequality. As the load further increases so does the tendency to delay commutation, so that the current collected by A will ever increase, at the expense of brush B; but it is not until all the current is collected by A that we need fear trouble from sparking. Consequently we can by this method commutate successfully an overload which an ordinary machine could only deal with were its interpoles made initially twice as strong. By making the commutating pole still stronger, and normally diverting a larger proportion of the current, we can arrange for good commutation over still wider limits. A modification of this scheme is shown in Fig. 2. Here, in the place of the diverter, we have a number of back turns upon the commutating poles. As the distribution of current between the two circuits changes with overload, these back ampere-turns are decreased, whilst the forward ampere-turns are increased. With this arrangement the effect upon the commutating pole is even greater than with the arrangement shown in Fig. 1.

In large machines it should be possible to save the cost of a separate diverter by using the series field coils for a resistance in circuit with brush B.

The tests were performed upon the 15 H.P. (220 volt, 60 amperes) dynamo, the dimensions and electrical details of which are given by the author.

In making the experiments the positive brush-holders were removed and replaced by the special brush-holders, made of red fibre, and were fitted with four carbon brushes, each of which was pressed down upon the commutator by a separate brass spring.

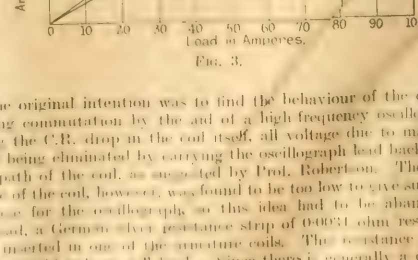


Fig. 3.

The original intention was to find the behaviour of the current during commutation by the aid of a high frequency oscillograph, using the C.R. drop in the coil itself, all voltage due to magnetic lines being eliminated by carrying the oscillograph lead back along the path of the coil, as suggested by Prof. Robertson. The resistance of the coil, however, was found to be too low to give sufficient voltage for the oscillograph, so this idea had to be abandoned. Instead, a German silver resistance strip of 0·0031 ohm resistance was inserted in one of the armature coils. This resistance gave a drop of 0·12 volt on full load. Since there is generally a drop in the neighbourhood of 1 volt under the carbon brushes, this additional drop is negligible. The resistance of the armature was 0·083 ohm, so even if there were no brush drop the resistance strip means only an increase of 1 per cent.

The tests were made by circulating the power between two continuous-current machines, as in a Hopkinson test, one of the machines

[illegible]

being fitted with the double brush. The current from one-half of this brush is connected through the commutating pole winding and the other through a diverter. Ampere meters in each circuit showed how the current divided.

Should the diverter resistance be too high, too great a fraction of the load current will pass through the interpole winding. This will strengthen the pole and generate a greater commutating E.M.F in the coils under commutation than is required to overcome the reactive E.M.F. Therefore the potential of the bars under the brush B will be raised, thus driving additional current through the diverter, notwithstanding its higher resistance. The amount by which the potential of the brush B is raised above that of A is termed in this Paper the correcting voltage. This correcting voltage is said to be positive when the brush B is at a higher potential than the brush A (see Fig. 1).

In the first series of tests all four interpoles were connected in series when their resistance was 0·08 ohm. Divided brushes were fitted upon the positive pole only, the negative brushes being those belonging to the machine. The diverters were choking coils with moving iron cores. The resistance of each choker was approximately 0·15 ohm.

Since the brush position has a considerable effect upon the distribution of the current under the brush, it was important to get the brushes in the neutral position, *i.e.*, right under the commutating poles. To do this a voltage curve was taken round the commutator; the slope of the line is a measure of the strength of field, so the position of the extra commutating field introduced by the interpole can easily be detected.

In order to find out how the load on the machine affected the distribution of current between the brushes A and B, a series of load

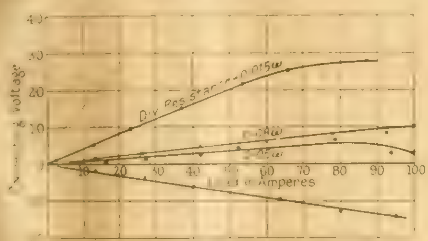


FIG. 4.

tests were now performed. Loads were applied from 0 to 100 amperes. Readings were taken of

1. Total load current.
2. Current through interpole circuit.
3. Current through diverter circuit.
4. Voltage observed between the two halves of the divided brushes.

The load was applied by directly coupling the machine to a similar machine and circulating the power in the Hopkinson method. During the first tests the special machine was run as the generator of the combination. In order to ascertain how the current would distribute itself if the influence of the commutating E.M.F. were removed, the machine was closed down after each test, and the current was passed through the armature while stationary. The distribution of the current between the commutating pole and the diverter was noted. The distribution in this case was determined only by the resistances of the diverter and interpoles. A curve was then plotted showing how the commutating pole current [illegible] with the load current [illegible]. An example of the type of curve obtained is shown in Fig. 3, where the higher line represents the commutating pole current as determined by the resistances of the two circuits. The lower line is the current as reduced by the double brush. It will be seen that in this diagram the interpole is [illegible], the extra strength being required to generate the correcting [illegible]. In this test the diverter resistance was nearly twice that of the interpoles, [illegible] nearly four times [illegible]. Some more tests were made using different diverter [illegible]. In Fig. 4 are curves showing how the correcting voltage varied with the load current in a series of these tests. The [illegible] voltage was obtained when the [illegible] was too low. [illegible] from a consideration of these curves that the interpoles [illegible] been [illegible] in these [illegible].

With the intention of [illegible] at what [illegible] begins in the poles, the following tests were [illegible]. [illegible] was excited by a separate source and the commutating poles excited from an outside [illegible]. The connection [illegible] the

voltage observed [illegible] commutating pole [illegible]. [illegible] some [illegible] indirectly [illegible] ampere-turns upon the commutating pole a[illegible] for driving flux across the [illegible] balancing the armature reaction; and on [illegible] very [illegible]. [illegible] be obtained from Fig. 5, in which the upper lin[e represents the] voltage which corresponds to any particular current in the i[nterpole] as obtained by this method, whilst the lower represents the [illegible] observed during a load test upon the machine.

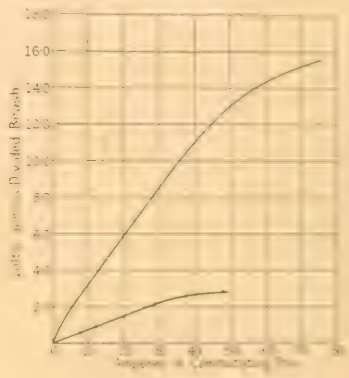


FIG. 5.

In order to obtain [illegible] attempted [illegible]. Two alternators were belted up for the purpose [illegible] load [illegible]. [illegible] 100 [illegible] instrument [illegible] amperes [illegible] seconds [illegible].

The [illegible] Fig. 6 is typical of a large number of [illegible] the current in the commutating [illegible]

FIG. 6.

[illegible]

flow through the commutating pole winding, and this in turn strengthens the pole.

When the diverter resistance is too low, we require from the onset a negative correcting voltage, *i.e.*, one that tends to strengthen the commutating pole. As the saturation begins this negative voltage, *i.e.*, excess of reactance voltage over commutating voltage, must increase still more rapidly.

The maximum voltage in each case was reached at a load of about 170 amperes. In each case, also, the curve of current through the

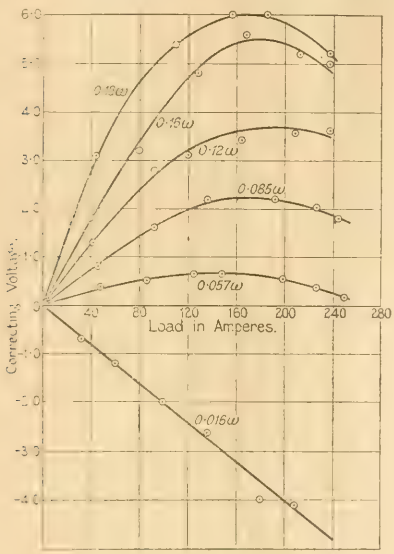


FIG. 7

interpoles shows a sharp bend in this neighbourhood. This is evidently the point at which saturation occurs. It was found that when the diverter was made of too low resistance a very heavy current, sometimes as much as three times full load current, would circulate between the brushes *A* and *B* when they were connected together by the short-circuiting switch. This current caused spark-

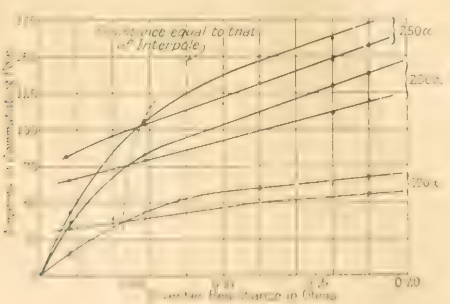


FIG. 8.

ing and burning under the brushes. When the switch was opened so that the [illegible] voltage was operative in adjusting the excitation of the pole, the amount by which the current from brush *B* exceeded that from brush *A* was only about 60 per cent. of full load current, and the commutation was good.

[illegible] the resistance of the diverter was at light load [illegible] the brush exerted a small positive voltage to [illegible] the commutating pole. As the load increased [illegible] began to become saturated, and so was too [illegible] passing through zero at a load of [illegible] amperes. [illegible] the distribution of the current between [illegible] could not be [illegible] by connecting the [illegible] *A* and *B* [illegible] the pole has the right strength for that load.

If the load had been further increased, the correcting voltage would probably have reversed.

Fi.. 8 is plotted from this series of results. It shows how the distribution varies with diverter resistance for three loads viz. 250, 200, and 100 amperes. In each case the curve springing from zero is the current flowing in the commutating pole when the two parts of the brush are connected together. From this curve we can see:

(*a*) That the correct diverter resistance is about 0·05 ohm, *i.e.*, the commutating pole has about $\frac{0{\cdot}08+0{\cdot}05}{0{\cdot}05}=2{\cdot}6$ times as many turns as necessary.

(*b*) In the 200-ampere case, if we increase the resistance of the diverter from 0·02 to 0·2, *i.e.*, 10 times, we only increase the current from 66 to 120 amperes in the commutating pole. The resistance is bound to have an effect, since it is only by destroying the balance that the correcting effect can be caused.

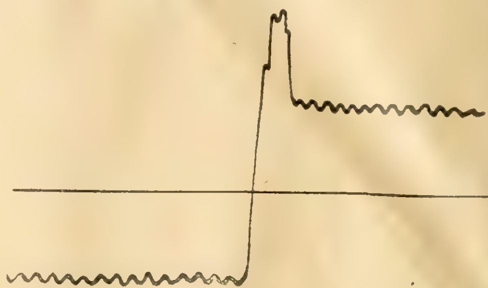


FIG. 9.

(*c*) If we draw a line through the points of intersection of these three pairs of curves we find that the same diverter resistance does not give the correct excitation of the interpole for different loads if the correcting effect is not present. A load of 250 amperes requires a higher resistance in the diverter than a load of 100 amperes.

If we plot the maximum correcting voltage against diverter resistance, we find that the point where the maximum voltage is zero is evidently the correct diverter resistance for light loads, so by exterpolation this gives a value of about 0·045 ohm.

From the experiments thus far we have discovered that the double brushes can exert what we have termed a correcting voltage, and this voltage can, and does, beneficially affect the distribution of the load current between the commutating pole and its diverter. This voltage reaches its maximum at about three times full-load on the machine when the diverter resistance is too high. When the diverter is too low, the voltage is in the rerverse direction, and seems to follow a straight-line law.

Oscillograph records were taken on a Duddell high-frequency oscillograph to see how the current changed in the coil under commutation. The instrument recorded the drop in pressure in the small resistance in series with the coil. A record was taken first

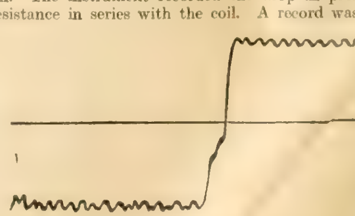


FIG. 10.

[illegible] the brush acting as a single wide brush, and, secondly, with the switch open, so that the two halves of the double brush were in [illegible] with the parts of the circuit shown.

Fig. 9 is one of the records taken when the brush was acting as a [illegible] brush, with an adjustment of the commutating pole purposely made too strong. The current rises quickly from a negative value to a positive value far exceeding the load current which [illegible] be carried by the coil. It is then brought down to the correct value by the resistance of the arc under the brush just as the [illegible] leaves the brush. Fig. 10 is a record taken with the same adjustment of the commutating pole diverter as before, but with the switch open so as to bring into action the self-adjusting feature of the double brush. Here the current rises from the negative

value to the correct positive value almost in a straight line. The commutation was perfectly sparkless, notwithstanding the ill-adjustment of the diverter. Other diagrams are presented in the original Paper showing a case with the diverter adjusted to make the pole far too weak, and other instances of more or less faulty commutation.

In order to obtain some idea of the variation of the flux in the commutating pole, a search coil consisting of two turns was wound upon the pole tip and connected to a flux-meter (Grassot).

In each test in which the flux-meter was used it was noticed that this saturation took place at a load of 300 amperes approximately. At this load, the flux in the air-gap required for good commutation is only about 3,000 C.G.S. lines per square centimetre. A very large amount of leakage accounts for the saturation, however.

Tables are presented by the author giving the results of a series of tests using diverters of resistances of 0·059, 0·048, 0·035, 0·028 and a short length of heavy cable, this latter being practically equivalent to a short-circuit across the poles. A diverter resistance of 0·028 ohm was evidently the best. Initially the diverter resistance is slightly too high, so the brush exerts a voltage tending to drive current through the diverter. This voltage at any instant is equal to twice the product of the diverter resistance and the extra current forced through it, together with an additional drop due to the increased current density under the leading part of the brush. As the interpole saturates, more current is required to maintain its flux, so this correcting voltage must decrease. This continues until it reaches zero—*i.e.*, the current in the commutating pole is just what it would [illegible] creases, [illegible] now to [illegible] of the [illegible].

With [illegible] normal load [illegible] load the [illegible] the [illegible] to this density is fairly high, and acts against the rectifying effect of the brushes.

The [illegible]

1. It is [illegible] make a [illegible] commutating [illegible] must be [illegible]

2. When [illegible] strengthen the [illegible] brushes. In [illegible] of nine times full-load [illegible] ing.

3. Better results [illegible] initially a little too great. In this case a [illegible] will be exerted on normal load. On overloads this voltage will decrease to [illegible] voltage between the [illegible] obtained [illegible] already on normal full-load.

THE HIGH-TENSION MAGNETO WITH SPECIAL REFERENCE TO THE IGNITION OF AEROPLANE ENGINES.*

BY A. P. YOUNG.

(*Concluded from page* 1001, [illegible] *LXXIX*.)

Summary.—The author explains the principles underlying high tension [illegible] in the design, as affecting the efficiency of performance and the nature of the spark [illegible] the flux and the importance of remanence and coercive force in the magnets [illegible] the spark is considered, and some details are presented to illustrate the need [illegible] shape. Finally the author gives some instructions as to the care of magnetos [illegible]

APPENDIX.

SOME NOTES CONCERNING BATTERY IGNITION SYSTEMS.

The [illegible] of the System in America.—The battery system of ignition is now being used more extensively for automobile work than the high-tension magneto. In Fig. 18 two curves are given indicating American practice since 1913. The percentages, which relate to all

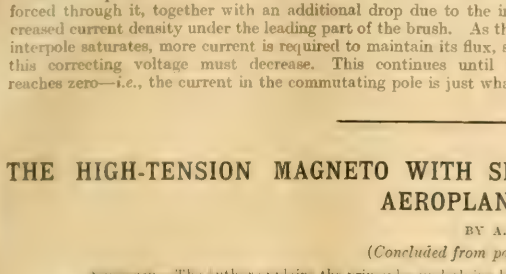


FIG. 18.—CURVES INDICATING THE TENDENCY TO REVERT TO BATTERY IGNITION IN AMERICA.

types of American [illegible], excluding the Ford, have been compiled by the "[illegible]" of America.

Year	Percentage of cars fitted with Magneto	Battery System
1913	[illegible]	[illegible]
1914	[illegible]	[illegible]
1915	[illegible]	37·9
1916	[illegible]	[illegible]
1917	[illegible]	[illegible]

[illegible] undoubtedly [illegible] The battery system [illegible] likely [illegible] in America, because [illegible] the [illegible] of electric lighting and [illegible] in that country [illegible]

good arguments [illegible]

[illegible]

* Abstract of a Paper read before the Aeronautical [illegible]

through the primary at low speeds. Iron wire is most frequently used for this unit, because it increases its resistance rapidly with increase in temperature, thus automatically preventing any appreciable change in the current.

The primary winding is connected in series with the resistance R and the contacts A, direct across the battery, while the secondary winding is coupled up to the rotating arm of the distributor in the usual manner. In fact, if the battery resistance R be deleted so that the primary is short-circuited on itself when the contacts A close, the connections correspond exactly to those of the high-tension magneto. The only vital difference between the working of the two systems is that whereas in the magneto the current in the primary is "induced" by the rotation of the armature in a magnetic field, in the other system current is supplied by the battery at a practically constant voltage.

Usually the contact-breaker and distributor form one complete unit, the contact-breaker cam and distributor arm being fitted to the same spindle. It is necessary with some systems to provide for automatic "advance" of the spark with increase in speed, and this result is achieved by driving the contact-breaker cam shaft through a spring-controlled centrifugal governor.

The contacts A, which in many cases are made of tungsten, are first closed for a certain period—during which time the current in the primary grows in value—and then suddenly opened. At that instant the high-tension spark occurs as a result of the enormous voltage induced in the secondary by the collapsing of the magnetic field created by the primary current. The intensity of the high-tension spark is dependent—other things being equal—on the value of the primary current that is broken when the contacts A separate.

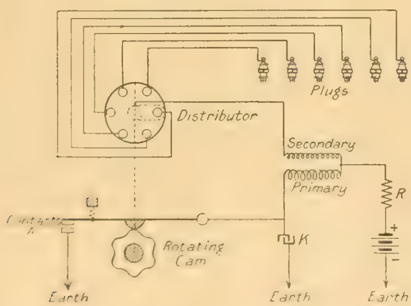


Fig. 19.—Modern Battery and Coil, High-tension, System. (As used in America).

Theoretical Considerations.—When the contacts close a steady and constant voltage E is applied to an inductive circuit which comprises the primary winding in series with a certain resistance, and the current grows from zero in conformity with the well known exponential law:—

$$i = \frac{E}{R}\left(1 - \epsilon^{-\frac{Rt}{L}}\right) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Where—

i = instantaneous current—amperes.

$R = r + r_b$ = total resistance of primary circuit—ohms.

L = coefficient of self-induction of primary—henries.

E = battery voltage.

t = time in seconds, measured from the instant at which the circuit is closed.

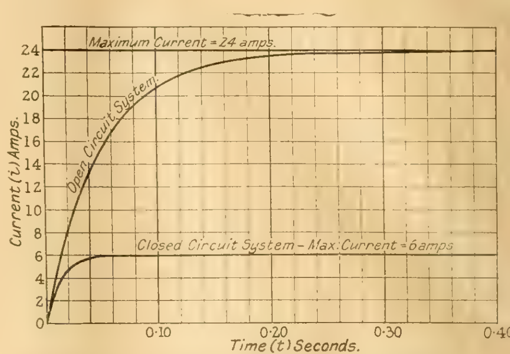
r = resistance of primary—ohms.

r_b = ballast resistance—ohms.

During the short interval of time that the primary current is growing, a magnetic field is being created by the current, and it is by virtue of this field [illegible] that energy is stored in the winding. At the instant of [illegible] the magnetic field suddenly collapses, and induces in the secondary winding an enormous voltage which is sufficient to produce a spark at the plug. The action is analogous to what takes place in a high-tension magneto. A certain amount of energy is lost [illegible], but probably something like 70 per cent. of the energy stored in the primary is available for ignition. In considering the [illegible] of different ignition coils, therefore, we are [illegible] chiefly concerned with the [illegible] L and the value of the current at [illegible]. The latter can be readily calculated for known conditions, from equation (1). The working of this formula can be explained by applying it to a concrete example.

Assume that— L=0·0125 henry.
R=0·25 ohm.
E=6 volts.

The growth of the current in the primary circuit under these conditions is shown by the larger exponential curve in Fig. 20, calculated from equation (1). At the end of 0·3 second, however, a steady condition has been reached, the current curve being for all practical purposes merged with its asymptote (at 24 amperes). In an interval of only 0·0033 second the current has reached a value of 1·5 amperes—*i.e.*, 6·2 per cent. of its final steady value in less than one hundredth of the time taken for that steady condition to be attained.



Curves calculated for following assumed conditions, which are representative :—
Open circuit system: L=0·0125 henry. r=0·25 ohm.
Closed circuit system: L=0·0125 henry. r=0·25 ohm.
Ballast resistance—r=0·25 ohm (when cold).

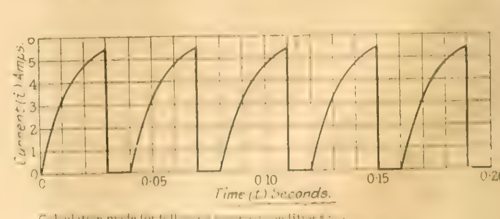
Fig. 20.—Battery Ignition Systems. Typical Curves Showing Growth of Primary Current.

Let us suppose that a ballast resistance of 0·75 ohm is connected in series with the coil just considered, bringing the total resistance of the primary circuit up to 1 ohm. The maximum current (I) is now reduced to 6 amperes. The smaller curve in Fig. 20 represents the growth of the current under these new conditions. The ratio L/R (usually called the "time-constant" (K) of the circuit) is the time taken for the current to reach 63·2 per cent. of its final and steady value (I).

The Vital Importance of the Contact-breaker. The form of curve to be aimed at is settled by the characteristics of the contact-breaker mechanism used in series with the primary winding. These mechanisms can be classified under two distinct groups :—

1. The "closed circuit" contact-breaker.
2. The "open circuit" contact-breaker.

The "closed circuit" contact-breaker corresponds in principle to the mechanism adopted on many high-tension magnetos, in that the circuit is closed for the greater portion of the time interval between successive sparks. At the instant of firing the circuit is rapidly broken and then immediately made again. It is not essential that the current curve be abnormally steep at the beginning, and the lower curve in Fig. 20 would be suitable. In fact, the values of (L) and (R) chosen as a basis for this curve are quite representative of the "closed circuit" battery system used in America at the present day.



Calculation made for following assumed conditions:—
Battery volts 6. L 0·0125 henry. Speed [illegible]00 revs. per min.
Ballast resistance r 0·75 ohm. r 0·25 ohm. Period of closed circuit / Period of open circuit = 3.

Fig. 21.—Battery Ignition Systems. Current Wave for Typical Closed Circuit System.

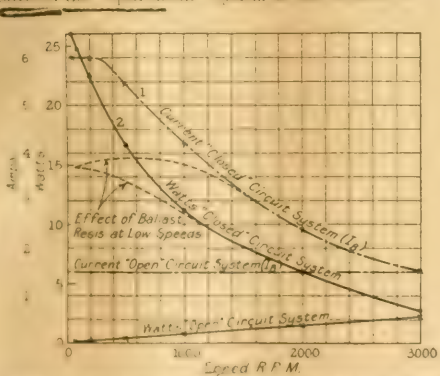
Considering the case of a six-cylinder engine running at 2,000 revs. per min., 100 breaks per second would be required—that is, the interval between successive breaks would be 0·01 second. Assuming that the ratio,

$$\frac{\text{Time circuit is closed}}{\text{Time circuit is open}}=3{\cdot}0,$$

then the primary is closed for 0·0075 second at this speed, and open for 0·0025 second. This means that at the instant of "break" the primary current has reached the value of 2·4 amperes. At lower speeds, the time during which the primary is closed would be correspondingly greater. Thus, at 1,000 revs. per min. the primary would be closed for 0·015 sec., and at "break" the current would be 4·2 amperes. At very low speeds, say, below 200 revs. per min., the maximum current (I) would be broken in every case.

With the "open circuit" type of contact-breaker mechanism as formerly used in the Attwater-Kent system, the primary circuit is open for practically the whole time, and is closed for only 0·0033 second. This time interval is, furthermore, independent of the speed.

When the "open circuit" type of contact breaker is used, the current curve must be very steep at the beginning, so that the current in the primary can reach an appreciable value before the circuit is again broken. The large curve in Fig. 20 is suitable for these conditions; if the primary be closed for 0·0033 second, the current will have reached 1·5 amperes. This is the current (I_B) that would be broken. Here again, the assumed conditions are quite representative of the "open circuit" system as used in America.



[illegible] curves 1 and 2 are [illegible] on the assumption that the ballast resistance does [illegible]. The [illegible] at low speeds is indicated by the dotted curves.

Fig. 22.—Battery Systems of Ignition. Calculated Curves showing Current and Power Consumption of Typical Open and Closed Circuit Systems.

Under the head of the electrical characteristics of the system the author works out the relation for the energy consumption, and applies it to two practical cases, involving respectively an open and a closed circuit system. These figures are plotted in Fig. 22. Curves showing the watts consumed indicate clearly that: (a) The power consumption with an "open circuit" system is extremely small as compared with a "closed circuit" system. (b) Whereas the power [illegible] with the speed in the first case, the reverse is true in the second case.

When considering the overall efficiency of a battery system it must be [illegible] that the energy contained by the [illegible] from the battery [illegible] [illegible] [illegible] [illegible]

[illegible]

When we come to [illegible] however, [illegible] far superior. [illegible] which of necessity delivers a very feeble spar[illegible]

The [illegible] magneto gives a spark energy at high speeds of the order of [illegible] energy remains constant over the wh[illegible] gives a spark that becomes more a[illegible] the spark intensity is not of such vital [illegible]

This is [illegible] either battery system, and one that enables the magneto to give more satisfactory results under w[illegible] has shown that a spark which increases its intensity (and flame) with the speed, is to be [illegible] of advancing the spark, by automatically speeding up the propagation of the explosive wave.

In the [illegible] obtained, particularly at low speeds, but the int[illegible] falls off with [illegible] required for the very best results.

In a final appendix the author investigates mathematically some formulæ for [illegible] dividing the time period into two sections. The method is illustrated by a practical example.

MR. J. S. HIGHFIELD'S PRESIDENTIAL ADDRESS TO THE ASSOCIATION OF SUPERVISING ELECTRICIANS.*

Before this war broke out there was [illegible] progress, the enemy then, as now, being mainly German, and the most serious efforts were being made and invidious methods used to turn us out of markets which we had long enjoyed. In some branches of our own business competition had run to ridiculous lengths, the result being that prices were cut to such a low figure that traders could not live, and then, [illegible] be reduced to suit the low [illegible] carried out with poor material and often with poorly paid labour, and with little [illegible] inadequate profit to the [illegible] state under these conditions. [illegible] earned and consequently [illegible] best men avoiding it and [illegible] are better rewarded. [illegible] credit, with the result [illegible] [illegible]

plant and must drive the manufacturer when he can to the closest competition in prices, with the result that quality is reduced and skill and labour are inadequately paid and experimental designs leading to improvements are strictly limited to the one direction of reducing cost. I do not wish to be misunderstood in this matter. I realise the great advances that have been made in all directions for many years, but I have no hesitation in saying that progress would have been greater had profits been larger and particularly if the whole business had not been hampered from its inception by faulty and restrictive legislation.

Some may say all this is true as regards the supplier of energy that the inadequate profits of the supplier may lead to low prices being paid for plant, but that, on the other hand, low prices help your contracting business. I agree, and I am no advocate for high prices, but I like to see the prices reduced after adequate profits have been earned and the business largely financed out of these profits. In this way prices can be rapidly reduced so long as the output increases, which the reduced prices will always ensure. Low prices brought about in this way are based on a sound foundation and benefit everyone. Low prices which are such as to bring about the ultimate ruin of the business may lead to the temporary benefit of a small number to the detriment of others, but they can never result in permanent benefit to the industry as a whole.

What you want to work for in the future is to make your business a well-paid one, carrying out good work and in sufficient volume to enable it to be done at low prices. You do not want low prices accompanied by low wages and inadequate profits. I suggest that the desired result can best be attained by working together and considering the general interest.

I want to say a few words about another aspect of your business. I am glad to see that so many of your papers deal with the difficulties encountered in using the plant and material supplied to you. There is no way so effective in improving design as the clear realisation and the statement of the defects of existing apparatus. This can be done only by the men in actual daily touch with the difficulties. The great hindrance to successful standardisation is the difficulty of finding out the defects in existing gear. The supplier of the gear does his best and sends out what he considers to be an effective design, but no matter how careful he is, it is impossible for him to foresee all the conditions that arise in practice—they are realised to the full only by the user. If the user is unskilful and the apparatus very defective probably it fails altogether; then an improvement can easily be made. A more common experience is that the apparatus is slightly defective and the user skilful, with the result that the user, by small modification, makes the apparatus work sufficiently well. The important matter is to find out about these modifications. I think you would do a great service to the wiring business if you could arrange to collect as much information as possible about the defects in the existing gear which you use, and make suggestions as to the remedies you have found necessary and also indicate how permanent improvements could be made.

There is much talk about higher wages in the future; it is a loose expression and really meaningless. Wages are paid in money and money is only useful as a means of exchange. No one wants money as money; we want the things and the service which it will buy, or which it can be exchanged for. If wages are increased without increase of output it follows that the commodity produced costs more. When wages are increased in a few trades only the men in those trades benefit, because they can still buy at the old prices the products of other trades where wages have not increased. When, however, wages in all trades are increased without a general increase of production, the price of everything is also increased and no benefit follows.

But better wages are desirable, using the expression in the sense that the earner can get a better exchange, and with more work done by each man, and more men and women working, the desired result can be secured. This desirable result can be furthered by using standard designs, labour-saving machinery, and better skill in direction. But the one great essential is to secure a large and increasing market for labour and the things it produces.

NOTES ON THE DESIGN OF ELECTROMAGNETIC MACHINES.*

PART II.

DESIGN OF A SLOW-SPEED ALTERNATING-CURRENT GENERATOR.

BY STANLEY PARKER SMITH, D.SC.

(*Continued from page* 8[illegible], *Vol. LXXIX.*)

Summary.—In Part I of the article the author deals with some of the main principles underlying the design of alternating-current generators. In Part II these principles are applied to the design of a low-speed, three-phase alternator, giving 750 kw. at 2,200 volts when running at a speed of 250 revs. per min. In Part III a three-phase turbo-alternator is designed to give 2,000 kw. at 3,000 revs. per min. at a line pressure of 500 volts, and the mechanical stresses in the rotor are discussed.

Let us now design the following machine :—

THREE-PHASE ALTERNATOR.

Output: 750 kw. at power factor = 0·8.

Line Pressure: 2,200 volts with phases joined in star.

Speed: 250 revs. per min.

Frequency: 50 cycles per second.

GUARANTEES.

Temperature rise: To be in accordance with the rules laid down by the Engineering Standards Committee, namely, after continuous working on full load temperature rise of stator core not to exceed [illegible] C., and of stator and rotor windings not to exceed [illegible] C. by thermometer or 55° C. by resistance.

Efficiency and regulation at power factors of unity and 0·8 to be stated.

Wave form: To be as nearly sinusoidal as possible and free from tooth ripples.

METHOD OF PROCEDURE.

It will be convenient to arrange the calculations under the following headings, though these cannot always be carried out in the order given, because it is continually necessary to check one part against another. A strictly logical procedure would entail much repetition, which must be avoided here.

1. Main dimensions.
2. Stator.
3. The magnetic circuit.
4. The rotor winding.
5. Efficiency.

1. MAIN DIMENSIONS.

With alternating-current machines it is a good plan to work with the phase pressure and phase current, and so avoid any confusion that might arise from the way the phases are interlinked at the terminals. We have then :—

Output of machine = 750/0·8 = 937·5 k.v.a.

Output per phase = 937·5/3 = 312·5 k.v.a.

Pressure per phase = V_p = 2,200/$\sqrt{3}$ = 1,270 volts.

Current per phase = I_p = 312,500/1,270 = 246 amperes.

Revolutions per second : n = 250/60.

No. of poles = $2p$ = $2f/n$ = 24.

In deriving the main dimensions of the machine, we can follow a method similar to that used for continuous-current machines, though here, of course, the number of poles is determined by the given speed and frequency.

For slow-speed alternators of this class, we can work with a

* The first article of this series dealt with Continuous-current Machines and the first part of this article appeared in THE ELECTRICIAN of June 2[illegible], 1917 (Vol. LXXIX., p. [illegible]).

maximum flux-density in the gap from 9 to 10,000, corresponding with a *mean flux-density* (or specific magnetic loading) :—

$$B_{mean}=\frac{\Phi}{YL}=5{,}500-6{,}000,$$

where Φ = useful flux per pole,
Y = pole-pitch in centimetres $=\pi D/2p$.
L = total core-length in centimetres.

The *ampere-conductors per centimetre of periphery* (or specific electric loading) can be taken :—

$$ac=\frac{ZI_a}{\pi D}=250-275,$$

where Z = total number of conductors in armature winding,
I_a = current per conductor,
D = stator diameter (bore) in centimetres.

Let us choose $B_{mean}=5{,}800$ and $ac=260$; then, assuming sinusoidal variation (*see* eq. 15, Part I.), we get, for the *output coefficient*,

$$C=\pi^2 K B_{mean}\, ac\, 10^{-6},$$
$$=9{\cdot}85\times1{\cdot}06\times5{,}800\times260\times10^{-6}=15{\cdot}8,$$

whence we get

$$D^2L=\frac{KV.A.10^3}{C\,n}=\frac{937{\cdot}5\times10^3\times60}{15{\cdot}8\times250}=1{\cdot}42\times10^6.$$

To split up this product, we must obtain suitable values for the peripheral speed and the core-length. The peripheral speed of engine-driven alternators usually lies between 25 and 35 metres per second, and such speeds seldom call for any special construction of the rotor, as is mostly needful with water and steam turbine-driven alternators. To obtain a cheap machine the diameter must be kept small, and for this reason the use of round poles is generally out of the question, unless the regulation guarantees are very stringent. The limit to reducing the diameter is reached when the space for the [illegible] becomes insufficient, or the machine becomes too long to cool efficiently. In 50-cycle alternators with a large number of poles the core-length varies from 25 cm. to 35 cm., and seldom exceeds 40 cm.

After various trials, it was found that a core-length of 32 cm. gave a suitable peripheral velocity for this machine.

With $L=32$ cm., $D^2=1{\cdot}42\times10^6/32=4{\cdot}4\times10^4$,
whence the bore $D=210$ cm.,
and the pole pitch $Y=\pi 210/24=27{\cdot}5$ cm.
$=v$ metres per second.

(It is useful to remember that at 50 cycles the peripheral speed v in metres per second is equal numerically to the pole-pitch Y in centimetres; for $v=\pi D n 10^{-2}=2pYn10^{-2}=2fY10^{-2}=Y$ metres per second when $f=50$.)

As a check on the above calculations, we have

$$C=\frac{937{\cdot}5\times10^3\times60}{210^2\times32\times250}=15{\cdot}9,$$

which agrees with the value of C we started with.

In a core length of 32 cm. we can have four ventilation ducts of 1 cm. each, leaving $32-4=28$ cm. of plates and insulation. With 24 S.W.G. (0·5 mm.) plates, the net iron length will be about $0{\cdot}9\times28=25{\cdot}2$ cm.

The poles are usually about 66 to 70 per cent. of the pole-pitch. If we make the pole arc $b=19$ cm., the ratio $b/Y=69$ per cent. [illegible] suitable.

The [illegible] of the machine will then be as follows:—

Diameter $D=210$ cm.
Periphery $\pi D=660$ cm.
Pole pitch $Y=27{\cdot}5$ cm.
Pole arc $b=19$ cm.
Core length $L=32$ cm.
Iron length $L_i=25{\cdot}2$ cm.
Vent. ducts Four of 1 cm. each.

We must now see if it is possible to obtain satisfactory stator and rotor windings with these main dimensions.

2. STATOR.

(*a*) *Stator Winding*.—There is no more important part of the design than the stator winding, and unless we [illegible] stator winding, we cannot have a good machine. With a phase [illegible] would [illegible] arrange [illegible] many [illegible] not [illegible] alternators, however, [illegible] limited to a small [illegible]

The [illegible] wave is to use a winding with a fraction[illegible] pole, and for this purpose a two-layer wave winding forms an admirable solution. The fact that the wave [illegible] tied down to a whole number of slots per pole [illegible] the greatest importance to the designer, who [illegible] find it a hard matter to obtain a suitable winding [illegible] freedom. With [illegible] 12 [illegible] cannot be obtained when $a=1$ or 2, for then [illegible] would not satisfy the condition $p'=3n\pm1$, as set forth in section 2, Part I. [illegible] no common factor greater than one with the number of phases $N=3$.

The wave [illegible] parts, so that [illegible] the three slip-rings would tap three points, thereby making connection with three similar parallel circuits. The coils of each phase would then be spread over 120 deg. In the [illegible] case, however, we need an open winding, so that [illegible] can be [illegible] winding at 60 deg., instead of at 120 deg. [illegible] spread, and so obtain the same output [illegible] winding. [illegible] parts of each phase can be joined either in ser[illegible] as we please. With the series connection, th[illegible] will be one-third of the number [illegible] nection, so that the space factor is much better in the former case. [illegible] per conductor $I=I_a=$ [illegible]

To design the winding, then, we can proceed as follows :—

Total number of conductors [illegible] $=698$.

Number of conductors [illegible]

Number of [illegible]

Instead of [illegible] be [illegible] on the theory of armature w[illegible] p. 18, [illegible] LXXIX [illegible] where we [illegible] of coil-sides per slot, $u=2$, [illegible] bers of slots, $S=36n\pm9$. [illegible] obtain a symmetrical three[illegible] though permissible. [illegible]

(*b*) *Connections of Stator Winding.* Though these are not needed at the present stage of the design, it will be as well to complete the stator winding straightway.

To find the points at which the stator winding is to be opened, it is well to obtain mental pictures wherever possible. For this purpose, the three circles in Fig. 12A, are drawn to represent the vector polygons of the three similar parts of the winding. Thus, each circle stands for a polygon of $C/N=351/3=117$ vectors (or sides), and all three are exactly alike.

The 117 coils represented by each polygon must now be divided into three equal phases at 120 deg. If the phase-spread were to be two-thirds of the pole-pitch, or if three-phase tappings had to be taken off a closed winding, we should merely have to split up the 117 vectors of each polygon into three equal parts of 39 vectors, and the problem would be solved; for it is quite obvious that if the numbers 1, 40 and 79, for example, divide 117 vectors into three equal parts, they will also divide 117 coils into three equal parts, whilst the vector diagram shows at once that the phases obtained thereby will be at 120 deg. Thus, for three-phase tappings off a closed winding, slip-ring I. would tap segments 1, 118 and 235; slip-ring II. would tap segments 40, 157 and 274; slip-ring III. would tap segments 79, 196, and 313. The equi-potential pitch is seen to be: $y_p=C/a=351/3=117$.

Since, however, a phase is only to cover 60 deg. of arc, the coils represented by each polygon must be divided into six groups, though it is clear the groups cannot be equal, since 117 is not exactly divisible by six. Consequently, we get virtually an unsymmetrical six-phase winding, but this is immaterial, so long as we get a symmetrical three-phase winding. By splitting the winding into alternate groups of 20 and 19 coils each, as shown in Fig. 12A, the three-phase points already marked are not altered, so that the symmetry of the three-phase winding is not affected.

The coil-joints (or segments) corresponding to the vectors marked can be written down at once from the obvious and simple relation, $x=1+(n-1)\,y_c$, where x denotes the joint corresponding to the vector n. In this way, the joints to be opened can be tabluated as below. It is seen that the numbers 1, 40, 79, &c., marking the three-phase points occur in the columns for both n and x, though in different cyclic order, thus confirming what we just said when discussing three-phase tappings. After a little experience a designer finds out many short cuts in drawing up such tables.

Vector n.	Joint $x=1+(n-1)y_c$.	Top coil-side $2x-1$.				Bottom coil-side $(2x-1)-y_f$.			
1	1	1 = a	in slot		1	676 = B	in slot		113
21	230	459	b	,,	77	432	C	,,	72
40	79	157 = a		,,	27	130	B	,,	22
60	308	615	b	,,	103	588	C	,,	98
79	157	313	a	,,	53	286	B	,,	48
99	35	69	b	,,	12	42	C	,,	7
118	235	469	a	,,	79	442	B	,,	74
138	113	225	b	,,	38	198	C	,,	33
157	313	625	a	,,	105	598	B	,,	100
177	191	381	b	,,	64	354	C	,,	59
196	40	79	a	,,	14	52	B	,,	9
216	269	537	b	,,	90	510 = C		,,	85
235	118	235	a	,,	40	208	B	,,	35
255	347	693	b	,,	116	666	C	,,	111
274	196	391	a	,,	66	364	B	,,	61
294	74	147	b	,,	25	120	C	,,	20
313	274	547	a	,,	92	520	B	,,	87
333	152	303	b	,,	51	276	C	,,	46

In addition to the joints we must know the coil-sides connected thereto. If odd numbers 1, 3, 5, &c., are used to denote top coil-sides a, b, c, &c., in the top layer, and even numbers 2, 4, 6, &c., the coil-sides A, B, C, &c., in the bottom layer (see Fig. 12), the top coil-side going to joint x is obviously $2x-1$ and the bottom coil-side $(2x-1)-y_f$. The position occupied by the coil-side in the slot can be written down by inspection.

To show the connections, the numbers of the joints to be cut and the corresponding coil-sides can be entered in a diagram, as shown in Fig. 12B, whence the groups to be joined together can be seen at a glance. In the present case, the three parts of each phase are to be joined in series, and the three phases interlinked in star.

For issuing instructions to the shops, it is well to have a diagram similar to that shown in Fig. 12C. This enables the winder to see at once in what slots the coil-sides lie where

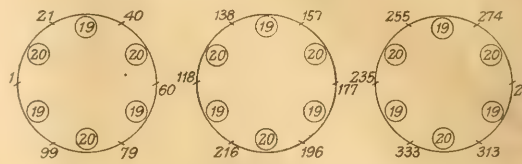


FIG. 12 (*A*).

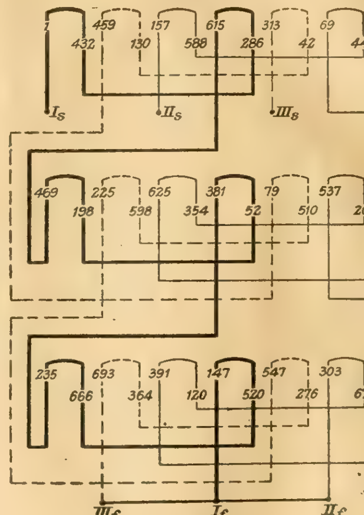


FIG. 12 (*B*).

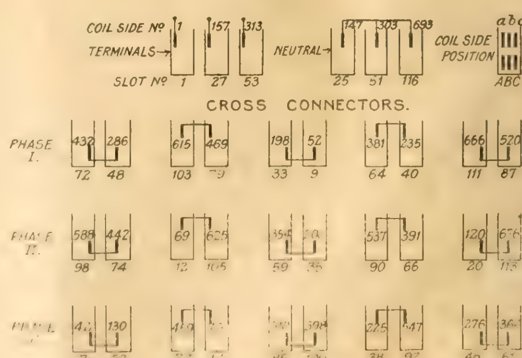


FIG. 12 (*C*).

special joints are to be made, and it is well for him to attach tallies marked as in the diagram to the respective coil-sides before bending the ends into shape.

The present winding has many cross-connectors, due to the fact that $a=3$. In the common winding, where $a=1$, these are reduced to one third.

(*To be continued.*)

SOME FEATURES OF STREET LIGHTING SPECIFICATIONS.*

BY W. EDGAR REED.

Lighting specifications should assure proper and adequate street illumination, and broad specifications covering intensity of illumination and other features might be practicable. Such specifications impose, however, a large amount of work in verifying the service, and it is, therefore, often considered preferable to specify merely the equipment which supplies the street illumination.

As city street lighting is usually a growth or evolution, specifications generally cover changes and extensions in existing systems, and engineering practice must adapt itself accordingly. The history of street lighting specifications in this country includes a number of more or less unsuccessful attempts to meet the situation. The inherent difficulties of measuring illumination have given rise to a tendency to prove service by records of energy supplied, checks of maintenance, and occasional checks of candle-power of lamps in a laboratory.

It is necessary to adapt equipment and lighting intensities to the requirements of different classes of streets interpreted in a practical way. Relatively small sections which it is desired to illuminate to high intensity, as in "white way" lighting, should not be paid for exclusively from city funds.

It is difficult to specify standards of intensity for various classes of streets, partly because high revealing power may depend upon other factors than intensity of illumination, such as direction of light, comparative brightness of surfaces, visual angle between street surface and lamp, number and intensity of light sources in field of vision, &c.

There are two schools of thought regarding distribution of light. The one favours fairly uniform intensity of light along the street, and the other a moderate diversity of intensity. Upon the whole, the average horizontal illumination intensity at the street surface seems the most satisfactory measure of light intensity. This should be several times greater at important street intersections than in other parts of the street.

It is desirable in the interests of economy to limit the number of different sizes and kinds of lighting units used. Average operating values rather than initial values should be employed in engineering calculations and in specifications. These may be, perhaps, 50 per cent. of the initial values.

Large units generally are more economical for street lighting than small units. In a particular case a comparison of 250 c.p. and 400 c.p. gas-filled incandescent lamps showed an increase for the latter of 60 per cent. in illuminating power with only 22 per cent. increase in cost. The cost per mile of lighted street should determine the economical choice of system and size of units to be employed, and this makes it possible to include in specifications the number, height, spacing and location of units. Provision should be made for limited increase or decrease of the number of units and for defraying the cost of changes. Lighting units should be specified as standard lamps which, when operated under standard conditions, give stated average and minimum candle power and light distribution. Provision should be made for substitution of more efficient light sources if available.

Lamp supports should be specified, and provision should be made for changing them and defraying the cost thereof. Supports should be selected with a view to pleasing appearance. The spacing for curved and for sloping streets should be shorter than for straight level streets. Every curve should have a lamp on its outer boundary.

Specifications should provide against excessive outages, which form one measure of the quality of the service. Specifications should also include a lighting schedule.

[illegible]

[illegible]

[illegible]

[illegible]

* [illegible]

ways. [illegible] source is not warranted unless it h[illegible] it should not be substituted unl[illegible] indicated after paying all fixed [illegible]

When illumination intensity i[illegible] of the lamps must be tested. This [illegible] and expensive work. Variation in initial va[illegible] variation with age, variation with condition [illegible] variation due to fluctuations in the service supply, all introduce difficulties in the way of arriving at a typical result.

The maintenance element is particularly important. Collection of [illegible]

[illegible] supply to lamps, verification of age and maintenance, [illegible] illumination intensity through photometric tests in th[illegible] The lamps themselves may be checked before installat[illegible] operation. Penalties may be applied for defici[illegible]

Specifications should include provisions on th[illegible]

1. Limited extension of [illegible]
2. [illegible]
3. [illegible]
4. Limited discontinuance of lighting.
5. Right of city to use parts of distribution systems for signal wires.
6. Approvals by city or its electrician.
7. [illegible]

In conclusion, [illegible] analyse thoroughly the whole situation with a view [illegible] the greatest service for the available appropriation. [illegible] and in the execution thereof the spirit as well as the [illegible] fulfilled. Recognising inability to forecast deve[illegible] engineer should seek to include in specifications the [illegible] than the details. [illegible] gradual improvement is desirable.

THE SIMPLIFICATION OF LINE TESTING.*

[illegible]

[illegible]

The Electrician.

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SPECIAL NOTICE.

Last week's number of "THE ELECTRICIAN" completed Vol. LXXIX. With next week's number will be issued the Index to the Volume.

THE DESIRABILITY OF PROFIT.

In these days when Socialists talk glibly of Capital having no claims to consideration it is well to emphasise the elementary and fundamental fact that prosperity and the payment of dividends go hand in hand. This theme is largely the text of Mr. J. S. Highfield's Presidential Address to the Association of Supervising Electricians. So long as adequate dividends are not paid, further capital cannot be attracted to an industrial enterprise, and the business cannot make satisfactory progress. In attempting to satisfy the shareholder who is receiving a poor return, steps are often taken to cut down the cost in every possible direction; but such steps usually lead to inferior production, lack of investigation, on which advance so largely depends, the carrying on of the business by men who are not sufficiently qualified or who are not sufficiently assisted, and, lastly, the payment of wages which are not as high as they might be. So long as an industrial concern is carried on under these conditions it is working under a great handicap. This has been the difficulty in the electrical industry in this country for many years. No doubt great advances have been made in many directions, but, as Mr. Highfield points out, there is no question that progress would have been greater had the profits been larger.

There are those who think that the lower the price of a commodity the better for the community at large. This idea, however, is not necessarily true. It depends entirely to what the lowness in price is due, for there are two ways in which low prices may be brought about. The first is by means of price cutting, in which firm A adopts a certain price in the hope that his competitor, firm B, will not be able to accept such a low figure; if this is so, then firm A benefits by a larger volume of business. In all probability, however, firm B proceeds to knock down prices still further, and finally neither firm makes a profit worth having. This is what may be described as the suicidal method of lowering prices, and the net result is bad for the community at large. Undoubtedly the purchaser obtains a product at a very low price, but the chance is that the product is unsatisfactory. Apart from this, however, the manufacturer is placed in an unsound financial position and is unable to make satisfactory progress in improving his products, with the final result that some foreign firm steps in and the turnover is still further reduced. The worship of cheapness for its own sake irrespective of quality and the ultimate effect upon the community, can only lead to national weakness. When once the home manufacturer is driven out of business there is then no longer the same inducement for the foreigner to keep down his prices, and the public cease to benefit.

The second method of lowering prices is by obtaining an increased output so that the costs may be lower. This method leads to increased prosperity and better conditions all round. It is in fact the only sound method of bringing about lower prices. To enable the manufacturer to reduce prices in this way, we think it will be admitted that a secure home market is a first consideration, and if this is obtained then foreign trade will follow.

Of course, it may sometimes be necessary to trade at a loss in order to develop a business. In fact this is generally the case with any new enterprise, but once this preliminary stage has been passed the only sound method is to trade in such a way that there is a reasonable profit. If a good profit is not being made the management are then faced with the problem of discovering to what this is due. It may be that the methods of manufacture are antiquated and that the firm consequently cannot compete against those who are up to date. This, we fear, has often been the case in this country. There may be other reasons with which those concerned in industrial matters are familiar, but the fact remains that so long as an industry does not make a good profit it cannot be considered to be in a satisfactory position.

REVIEWS.

The Trade of To-morrow. By Ernest J. P. Benn. (London: Jarrold & Sons.) Pp. 232. 2s. 6d. net.

This is one of the numerous works for which the war is responsible. Socially, politically and commercially we are expected to begin a new era after the war, and many active minds are at work sketching the outlines—to be later developed into working drawings—of the structures which are to be the means of effecting the regeneration of society.

"The Trade of To-morrow" is an outline sketch for commercial reconstruction. A friend to whom the author submitted the manuscript found fault with it because it deals only with material prosperity and dwells on the mere multiplication of *things*, as if they were a measure of human progress. The candid friend seems to us to be very unreasonable. The work aims at specific results in the production and distribution of material aids to comfort, and the consequent raising of the standards of life. The philosophy of happiness is a different theme, and its treatment should not have been expected in such a work. If the social simplicity of the Garden of Eden were restored, there is historic justification for the expectation that it would need subsequent reconstruction. The author accordingly adopts without inquiry the accepted standards as to the benefits to the community of trade and manufactures, and considers how these may best be developed for the benefit of the people and the promotion of the interests of the country.

The central idea is the promotion of Trade Councils. Every industry should have a Council to which the Government would delegate all questions connected with that industry. Premising that there are three parties interested in the results of industry—employers, employees and the State—the Councils should consist of elected representatives of the Trade Associations to the extent of one-third of its number, of the Trade Unions to another third, the remainder being composed of the official element—representatives of Government departments, men of science, and nominees of other bodies having an interest in the industry. By such means the drawbacks of competition and the advantages of co-operation are to be secured, restrictions on output removed, and distribution, especially in export markets, improved.

In the development of his theme the author indicates the failures of existing methods and the consequences which must happen from their continuance. As one reads, doubts and difficulties come to mind on various points, but before the book is finished one learns that these doubts have either been cleared up or are admitted as requiring more definite consideration for solution. The descriptions of existing Trade Associations read as being the statements of one who knows, and the chapter on Fiscal Reform, though cautious, is fairly sound. The fundamental errors of Government management in trading enterprises are well brought out, but that such errors are applicable to Local Government enterprise—though perhaps in a less degree—is not perceived. The official mind and the

official attitude are so clearly portrayed and so frankly condemned that one notes with some surprise the confidence with which the author concludes that the official admixture in his Trade Councils is so arranged as to be productive only of good.

Notwithstanding its subject, the book is very readable. There are several points where the reader wants to argue with the writer, and the style suggests that an opportunity for such argument would be welcomed, and that points would be enforced and doubts dissolved with calmness and deliberation. Whether or not the reader is convinced that the particular plan of reconstruction recommended is likely to attain all that is claimed for it, he is compelled to recognise the experience and earnestness of which it is the outcome. Education is one of the essentials for any satisfactory method of reconstruction, and an important element of education is thought. "The Trade of To-morrow" is distinctly educative, for it makes the reader think. J. E. K.

Electrical Laboratory Course for Junior Students. By MAGNUS MACLEAN, M.A., D.Sc. (London: Blackie & Son, Ltd.) Pp. 120. 2s. net.

This book is an enlarged and revised edition of that compiled by Archibald and Rankin, and issued by the same publishers in 1908. Its object is to replace MS. instruction sheets in electrical laboratories, and it is based on the experience gained in many years of teaching in the Electrical Engineering Department of the Royal Technical College of Glasgow.

The earlier [illegible] a few experiments [illegible] but the [illegible] part has already [illegible] for July 23, 1909.

From page [illegible] includes cable faults (Murray loop, search [illegible] tests); insulation [illegible] Crompton potentiometer [illegible] calibration of [illegible] the methods of [illegible] and wattmeters; [illegible] lamps; characteristics of dynamos and experiments on motors.

These additions [illegible] simpler and fundamental facts of the science clea[illegible] strated by a very [illegible] on electric and magnetic [illegible] appreciated by [illegible] altogether 63 experiments described in the text. [illegible] by 61 diagrams of connections, &c. In many cases [illegible] method of tabulating the [illegible] blank forms, and wherever experience has proved that there is a danger of wrong [illegible] conclusions to be drawn from an experiment [illegible] the student, and practical [illegible] consideration are pointed out as [illegible] [illegible]

UNDERGROUND TELEPHONE CABLES.*

BY GEORGES VIARD.

The rapid development of telephony has led, more and more, to the utilisation of underground cables instead of aerial lines. In many cases the latter method is obligatory owing to the large number of circuits. Extensions of aerial lines become more difficult every day; for the opportunities for conveying such lines along railways are continually becoming restricted owing to the fact that railways are themselves extending their installations.

It is therefore of interest to consider the technical conditions affecting the use of inter-urban underground telephone cables and the results that can be obtained from them from the commercial standpoint.

Ordinary telephone cables do not allow of transmission of messages to great distances. For long distance transmission one must have recourse to special improved types. Theory shows that increasing the self-induction of a line adds considerably to its powers of transmission. In practice there are two possible methods of increasing this self-induction. The first method, known as "krarupisation," from the name of the Danish engineer Krarup, responsible for this device, consists in increasing the permeability of the space adjacent to the conductors by surrounding the copper conductors with spirals of soft iron wire, 0·2–0·3 mm. in diameter.

The second process, which is designated also by the name of its inventor, Dr. Pupin, is termed "pupinisation." It involves the insertion of additional self-induction, in the form of coils, at convenient intervals in the circuit.

Dr. Pupin has also investigated the relation between a conductor of this type and a truly homogeneous conductor having the same self-induction and resistance, but uniformly distributed. He states that a non-homogeneous conductor is equivalent to a truly homogeneous conductor in the proportion [illegible] to [illegible]. The [illegible] the [illegible] distance between two successive self-inductions [illegible] corresponding to the length of the wave. [illegible] if [illegible] is the distance between two successive coils, λ the wave length, we have [illegible]

Pupinisation enables a much greater self-induction to be added than does krarupisation, and at a smaller expense. It is therefore in practice [illegible] largely employed in the construction of [illegible] urban telephone [illegible] importance. Krarupisation [illegible] effectively employed in very special cases. We [illegible] to the consideration of pupinised [illegible] results obtainable from them. The theoretical side of [illegible] has been very fully [illegible] in all its aspects, and [illegible] deal mainly with the practical side.

The first application of pupinisation date back to [illegible] ago. Since then we have passed through the exp[illegible] and the process has [illegible] that standard [illegible] as the [illegible] during [illegible]

The study of the [illegible] (1) The determination of the [illegible] per kilometre. (2) [illegible] self-induction [illegible] of working and [illegible] would be useless and even injurious to exceed. [illegible] termed the maximum self-induction [illegible] the [illegible] [illegible] with the [illegible]

[illegible]

* [illegible] of an article in [illegible] Annales des Postes [illegible] Téléphones.

only cause of distortion. The variation in the "admittance"* and in the resistance of the coils according to the frequency are the chief factors. For cables insulated with gutta-percha or paper the effective admittance is proportional to the frequency. The effective resistance of the inductive coils is likewise affected by the frequency owing to the losses in the iron through hysteresis and eddy-currents. Good transmission of words is, therefore, not achieved by the strict application of Pupin's law. A modification is necessary in order to take account of all the causes of distortion.

The wave-length, for a highly inductive line, is given by the formula:—$\gamma=2\pi/\omega\sqrt{CL}$, where C and L denote respectively the capacity and self-induction per kilometre and ω the frequency of the current considered. Pupin's law, stating that there a certain number of coils per wave-length, can always be finally put in the form: $CL_1l<A$, A being the factor which, as we shall see, must be determined by experience, l the distance between two coils, C the capacity per kilometre of the circuit and L_1 the self-induction of each coil. The quantity L_1 must be inserted because one assumes that the self-induction is due exclusively to the added coils.

In Great Britain this rule is adopted in the form: $CL_1l<25$, C being the capacity per mile expressed in microfarads, l the distance between two coils, expressed in miles, L_1 the self-induction total per coil, expressed in millihenries.

There is no change necessary in the formula if one substitutes kilometres for miles.

In America the rule has been stated in another form, namely: The front of a wave which progresses along the line must encounter at least 7,000 coils per second.

In Germany it is customary to derive another quantity, namely, the frequency of the free oscillations in an element of pupinised line. Each coil forms, together with the half-sections of the line on either side of it, an oscillating circuit, the inductance of which is L_1, and the capacity $\frac{1}{4}Cl$, taking account of the fact that the capacities of the two sections are situated in series. The frequency of the free oscillations in such a circuit is given by the formula: $\omega_0\sqrt{(L_1\frac{1}{4}Cl)}=1$. The pulsation ω_0 should be as different as possible from that of the currents to be transmitted. It is specified that ω_0 should have a value at least equal to 16,000.

The following table illustrates the very considerable differences in the rules followed in various countries:—

Country.	Maximum values of product, CL_1l.	Minimum number of coils encountered by the front of a wave in 1 sec.	Frequency of free oscillations in an element of line.	Relative number of coils used.
England	25·0	6,325	12,650	79·0
America	20·4	7,000	14,000	87·5
Germany	15·6	8,000	16.000	100·0

In France, in the first experiments, it was proposed that the main frequency should be above 16,000. Subsequently, it has been asked whether it would not be an economy and a simplification to follow the rule applied in Britain. From tests undertaken by the Post Office, it has been decided that the clearness of transmission was sufficient, and it has been decided, in future construction, to follow the rule.

The differences in the mode of distributing coils in different countries cannot be explained entirely by variation in quality of material employed or difference in language; they may be due to the lengths to which the effort to secure perfect clearness has been carried. It seems reasonable not to press this point too far, for the telephone is mainly intended for commercial use; that is to say, sufficient audibility and correct comprehension of spoken words are more important than the perfect and almost artistic reproduction of the timbre of a voice. Such refinements add to the first cost of installation as well as making extensions more expensive.

[illegible] that a series of coils having the inductances indicated in the above table are well adapted to normal practice. It is only in the case of very important connections that it will be found necessary to depart from these types of standard coils.

It is [illegible] to refer to the specification of coils, i.e., the [illegible] of quality of [illegible]. Inductance can never be added without at the same time increasing the resistance. It is usual to judge coils from this standpoint in terms of the factor R/L, the [illegible] being [illegible] at a frequency of 800. This factor is the [illegible] of the time-constant of the coils and represents the additional resistance introduced per henry of inductance. The

[illegible]

Nature of pupinisation.	Inductance of coils in henries.	Distance between coils in km.	Inductance added per km.	Values of CL_1l.	Characteristic.
Very weak.......	0·060	9·0	0·007	21·6	410
Weak	0·135	4·0	0·034	21·6	920
Average	0·175	3·0	0·058	21·0	1,200
Strong	0·250	2·15	0·116	21·5	1,700

N.B.—This table relates to the pupinisation of a cable having a capacity per kilometre of 0·04 mf.

The numbers indicated in the column under the heading "Characteristic" are values of $\sqrt{L/C}$.

diminution of this factor involves an increase in the amount of iron and copper used in the coil, and consequently in the bulk and cost of the latter. It is, therefore, necessary to make a compromise. For a diameter of 3 mm. we may have $R/L=50$, for higher diameters 35, and even, in exceptional cases, 25 or 20. The variation in effective resistance with frequency must also be limited as far as possible.

Other qualities which are desirable in coils are: (1) High insulation; (2) low mutual induction between adjacent coils; (3) small bulk; (4) feeble magnetic remanence. All these points deserve attention, conjointly with the matter of cost.

Returning to the table it may be remarked that each type of coil corresponds with a certain distance, and therefore a certain additional inductance per kilometre. The characteristic is the measure of the factor $\sqrt{L/C}$. This quantity determines the nature of the pupinisation, since, for a given power of transmission, it decides the necessary votage. The stronger the pupinisation the higher the voltage which must be applied to the line. While it is not difficult to ensure adequate absence of induction between neighbouring circuits in the case of ordinary telephone circuits, this is no longer the case for pupinised cables. On these cables one has always strong mutual induction if special measures are not taken to secure equilibrium of the capacities of the circuits.

Moreover, insulation defects become more marked as the voltage increases; consequently if there is not uniform admittance on each of the cables, we again get disturbance of equilibrium, which reveals itself as inductive effects. Finally it may be added that if the efficiency of the circuits is increased, all disturbances of E.M.F. produce a more marked effect than in ordinary cables. In practice, therefore, if one wishes to obtain exemption from interference with other circuits it is best not to pupinise too strongly.

There are other reasons for advocating relatively weak pupinisation. For example, in this case the distortion due to the coils is reduced to a minimum, and the characteristic is of the same order as that met with on aerial lines.

In determining the conditions of pupinisation one may either use wires of small diameter, strongly pupinised, or conductors of larger diameter, relatively weakly pupinised, that is to say, we may dispense with coils to some extent by using more copper and vice versa. In England and France it is usual to employ weak pupinisation for average distances. In America and Germany stronger pupinisation will be found. However, each circuit requires to be separately considered, and conditions which answer well in one case are not necessarily the best in another. The study of these conditions is essentially a matter for the specialist.

Finally, it is easy to demonstrate the general advantages, from the point of view of communication, of underground cables. Such cables are protected against weather, not only falls of snow, gales of wind, but the smaller irregularities caused by constant exposure to rain, which frequently derange aerial lines. The underground cable, protected by its conduit, is secure against mechanical rupture, whereas overhead lines are often frayed or broken. The telephone is an exceedingly sensitive instrument. The slightest irregularity of insulation, permitting contact with telegraphic or induced currents, will affect the transmission of sound; the same applies to thunderstorms which, in the case of aerial lines, may compel complete cessation of traffic. The underground cable is subject to none of these troubles, and one can always rely on an established connection. The absence of parasitic noises is so complete that it enables conversations to be carried on with much lower intensity of sound than when aerial wires are used.

It is true that the cost of installation of an underground cable is much above that of an aerial line. This circumstance is aggravated by the fact that a reserve of circuits must be provided which, during certain intervals of time, may be little used. But this higher first cost is largely compensated by the almost total absence of maintenance expenses, and the freedom from accidents.

BATTERY EXCHANGE SERVICE AT HARTFORD, CONN. (U.S.A.).*

For almost five years the battery exchange plan has been in force at Hartford, Conn. There are now 88 commercial electric trucks of different sizes operating under this plan.

The Hartford Electric Light Company took the agency for General Vehicle trucks early in 1910. When snow was on the ground or conditions were otherwise unfavourable two batteries were used in some of these vehicles in the winter. The batteries were handled in individual trays and exchanges made in less than 10 minutes.

This led to the evolution of the battery exchange plan in 1911. The customer purchases from the company a truck without battery while the company buys the batteries, charges them and installs them in the customer's truck. For service the customer pays a flat sum and for operation he pays on the mile basis, different rates being charged for trucks of different size.

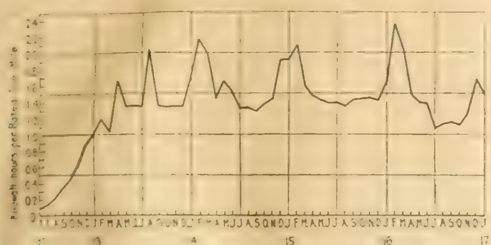


FIG. 1.—ENERGY CONSUMPTION PER RATED TON-MILE.

The electric light company agrees to furnish him with a fresh battery on demand, the whole operation consuming normally about 2 to 2½ minutes. The time lost, therefore, is less than the time required to fill up the gasoline tank of a gasoline truck.

The operation of changing batteries is very simple, and is essentially as follows: The incoming truck is run up on a couple of slightly elevated tracks and comes to rest with the battery directly over a hydraulic lift. An attendant who is waiting slips a Cown truck under the battery, the lift raises it to the battery, the hooks and connection of which are quickly unfastened, and the battery is lowered and taken to one side. The battery which is to take its place is all ready near by and is quickly wheeled into position, raised by the lift and the hooks and the connection fastened. The battery box is then locked up and the truck backs out.

To perform this changing operation three men are employed, two for battery change and one shift man who reads the odometer.

The changing peak occurs as a rule between 6.45 a.m. and 8.30 a.m. Friday and Saturday are the two busiest days, and particularly Saturday, when the stores keep open until 9 o'clock. Batteries are charged during off-peak hours. When the peak comes on, or should an accident occur, the batteries are pulled off the lines.

For the battery exchange system it has been found that 1.4 batteries are needed per car. There is therefore 0.4 of the total number of batteries always in a position to be in charge, the remainder being in service. For the charging of these exchange batteries [illegible] are used. These are housed in the battery exchange building, which used to be the company's battery sub-station, and even now is used as a sub-station to some extent. Here the company also distils its own water for the batteries, using one small electric [illegible] [illegible]. On the average about 100 gallons (379 l.) of distilled water is used daily. Altogether this service, with the small [illegible] battery [illegible], requires the employment of about 21 men. [illegible]

In addition to the building there is a garage company [illegible] which the company [illegible] customers [illegible] garage [illegible] which [illegible] the property of the electric light company [illegible] [illegible]. The garage is for night service [illegible] three men at work from 11 p.m. to 7 a.m.

The [illegible] charging equipment [illegible] [illegible] [illegible]

[illegible] charges regularly between 600 and 700 lighting and [illegible] [illegible]

[illegible] that would be incurred were it [illegible] system for trucks. In fact, it [illegible] for the exchange service, which [illegible]

[illegible] using it has increased materially, thereby lowering [illegible] per truck.

[illegible] stored in a place convenient to the owner [illegible] [illegible] Garage Co.

[illegible] rates being the same for both. The rates for cars using [illegible] vice are lower than for those with their own [illegible] that a smaller number of extra batteries [illegible] until morning.

[illegible]

[illegible] change customers under a mechan[illegible] best of running conditions at all times and at the [illegible] truck owner by increasing the driver's interest [illegible] and care of his truck." It is this [illegible] that is of especial interest. The [illegible] scheme. Should the amount [illegible] [illegible] the light company and, provided the ow[illegible] [illegible]

* Abstract of an article in the "Electrical World."

year, and 5-ton (4·5 metric ton) truck, $250 per year. These charges are payable in 12 equal monthly payments.

This contract is for one year, and covers all bills rendered by the garage company for material and labour used in the mechanical and electrical upkeep of the truck for certain items as described and with certain exceptions. The contract includes the regular care of controller, Morse chain and motor and one overhauling. Renewals of and repairs to various specified items are included in the contract.

It has been very difficult to interest customers in this plan because the customers as a rule figure that the cost involved is too high, and that they can do better on maintenance themselves. Out of 88 trucks sold on the exchange plan only 15 are on the maintenance contract.

From the customer's point of view the larger-size trucks are best, the operation being more economical. The demand for trucks of less than 1-ton (0·9 metric ton) capacity has fallen off to a point where the company has stopped selling these smaller sizes. For every truck sold a dividend is paid on each truck purchased in the previous year up to 25 trucks, as follows: 750 lb. (0·34 metric ton) size, $4 per truck sold, with a $2 increase for each size up to 5 tons (4·5 metric tons), on which the dividend per car sold is $14.

From the point of view of the customer the service is very satisfactory and economical in operation and maintenance.

Since the battery exchange system was started, in June, 1912, and up to the end of January, 1917, the total mileage was 2,009,807 miles (3,234,476·87 km.). The largest mileage in any single month was 56,402 miles (90,770·4 km.) in October last. The average miles per car per month since the plan was first started has been 678 (1,091·14 km.), with the largest month that of March, 1914, when the average mileage per car was 810 (1,303·57 km.), and the smallest month that of February, 1914, when the average mileage was only 309 miles (497·3 km.). The best mileages are obtained between March and November. The winter months as a rule show a very small falling off in mileage.

Table I.—*Monthly Scale of Charges under Battery Service System.*

	750 lb. wagon.	1,000 lb. wagon.	1-ton truck.	2-ton truck.	3½-ton truck.	5-ton truck.
Fixed charges						
Scale I.	$14.00 ($15.00)	$18.00 ($20.00)	$27.00 ($30.00)	$32.00 ($40.00)	$40.00 ($50.00)	$48.00 ($60.00)
Scale II.	$10.00 ($10.50)	$13.00 ($14.00)	$19.00 ($21.00)	$25.00 ($40.00)	$32.00 ($50.00)	$35.00 ($60.00
Rate per mile, cents:						
0–500 miles. ...	2½	3	3½	4½	6	7
500–750 miles	2¼	2½	3	4	5	6
750–1,000 miles .	2	2¼	2½	3½	3	4
For all excess above 1,000 m.	1½	2	2	3	3	4

The average miles per month for the 750 lb. (0·54 metric ton) truck during the first 56 months was 655 miles (1,054·12 km.); for the 1,000 lb. (0·45 metric ton) size, 743 miles (1,195·75 km.); for the 1-ton (0·9 metric ton) size, 456 miles (733·86 km.); and for the 2-ton (1·8 metric ton) size, during the first 43 months of its operation, 562½ miles (908·5 km.). The 3½-ton (3·15 metric ton) size has not been in operation long enough to make any deductions.

ENERGY CONSUMPTION.

The energy consumption through January last amounted to a total of 2,252,162 kw.-hours. In 1916 the energy used for this service was 733,326 kw.-hours. The average energy consumption has been 1·12 kw.-hours per car mile. In the winter months the energy per car mile is large. The maximum was reached in February, 1916, with an average consumption per car mile of 1·953 kw.-hours. In the summer the energy consumption is somewhat less.

The same general statements, of course, hold true for the energy consumption per rated ton-mile. A high consumption of 2·35 kw. per rated ton-mile was reached in February, 1916. In October last, however, the energy consumption per rated ton-mile was 1·107 kw.-hour. Ordinarily, however, the energy consumption per rated ton-mile is in the neighbourhood of 1·3 kw.-hour. How this consumption varies month by month is shown graphically on the accompanying curve (Fig. 1).

As the service has increased the plan has become less expensive per car to the light company. In the accompanying table are shown figures representing the percentage of cars changing batteries every day and the number of cars stalled for the months of June and December, 1912, 1913, 1914, 1915 and 1916. The number of stalled cars includes every cause whatever and does not necessarily imply a condition of exhausted batteries.

The Edison batteries used on the exchange service are subjected to very hard usage. At the end of the first 4½ years the number of cells in use was 6,936, and their service was equivalent to 226,812 cell-months. Only 225 cells have been returned to the factory for repairs in that period. Of these 51 were on account of leaks or broken seams and the rest for other causes, such as failure to charge up or broken terminals.

Table II.—*Exchange Load and Cars Stalled.*

	1912		1913		1914		1915.		1916.	
	Jun.	Dec.	Jun.	Dec.	Jun.	Dec.	Jun.	Dec.	Jun.	Dec.
[illegible]	*	*	*	949	1,091	1,132	1,291	1,188	1,631	1,770
[illegible]	*	*	*	703	633	1,281	988	1,152	1,143	1,623
[illegible]	*	*	*	74	68	90	64	97	70	92
No. of cars stalled ...	*	*	*	24	12	25	3	26	16	29
[illegible]	*	*	*	3	1 p.c.	2 p.c.	1 p.c.	2 p.c.	1 p.c.	2 p.c.

* No data obtained.

CORRESPONDENCE.

THE CITY GUILDS' SUBJECT: "ELECTRICAL INSTALLATION WORK."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: This fundamentally important subject, which, until a year ago, suffered from the entirely inadequate name of electric wiremen's work, is once more under a cloud, and we wonder what the newly-appointed examiner, Mr. W. R. Rawlings, thinks of the matter.

In the new session's "programme" of the City and Guilds of London Institute there is a prefatory red-ink notice to the effect that the 1918 Exams. in the above subject will not be held if the war continues. A few non-electrical subjects are in the same boat, and there is a final threat that other examinations may have to be suspended or modified.

Right up to the present time the fundamental electrical subject has suffered from neglect at the hands of principals of institutes and heads of electrical engineering departments, who have consistently starved it, while spending money lavishly in other directions. In some institutions the subject is considered an outside one, and its teacher a temporary member of the staff.

To make matters worse, the C.G. examination authorities fenced the subject round with absurd barriers tending to discourage or render impossible attendance at the examinations. The various kinds of people who are concerned with electrical installation work cannot by reason of their employment always make the stipulated number of attendances; while no provision at all exists for private students to sit for examination. The introduction of this concession would have had surprising results in past years. Our own examinations make us feel certain on this point.

The final blow, the threat of "no examinations," is the more serious, as other classes will promptly be dropped. We say "other classes," because right at the beginning of the war some authorities straightaway "put the lid on."

To discourage this particular examination at a time when recruits to the ranks of electrical workers are badly wanted seems excessively feeble. It can hardly be a question of expense, for the latter must be very nearly proportional to the number of examinees.

We notice that the subject of gas fitting has not received a similar set-back. What have the I.E.E. and E.C.A. to say to this?

Up to the session 1915-16 the prizes offered for "Electric Wiremen's (now Installation) Work" depended on the generosity of the Goldsmiths' Company. Now there are none at all. Should this discontinuance of prizes be permanent so far as the Goldsmiths' Company is concerned, an excellent opportunity will be afforded the I.E.E., the B.E.A.M.A., or the E.C.A. of stepping into the breach.

The Society of British Gas Industries, the Institute of Builders, the Institute of Plumbers, &c., do their best to foster their respective industries in this way.

While the war is bringing home to millions of people the indispensability of electricity in various directions at the Front and in munitions works, it would almost seem that the authorities were bent on discouraging the study of fundamental electrical work, otherwise "electrical installation work."—We are, &c.,

London, Sept. 20. A. P. LUNDBERG & SONS.

BENJAMIN INDUSTRIAL SIGNALS.

The present prevalence of raids by enemy aircraft has given a new interest to electric warning signals. There is a growing tendency to install these in workshops, factories, mills, yards, business offices and commercial establishments generally, with a view to sounding a distinct note on the approach of hostile aeroplanes. Messrs. The Benjamin Electric (Ltd.), Rosebery-avenue, London, E.C. 1, are issuing a leaflet which describes two patterns of warning signals, one for direct current and the other for alternating-current circuits.

FIG. 1.—BENJAMIN INDUSTRIAL SIGNAL FOR D.C. CIRCUITS.

The former, which is illustrated herewith, is intended for use on parallel circuits only. We understand that this is provided with a [illegible] device placed across the magnet winding, which [illegible] sparking at the vibrator contacts. The diaphragm and other portions of the horn which are under heavy mechanical strain [illegible] of best spring steel. The signal is made in three sizes:—

For 240–250 volts, 0·07 amperes.
For 200–220 volts, 0·07 amperes.
For 100–110 volts, 0·10 amperes.

The signals both of this type and the alternating-current type can be supplied for lower voltages down to 6 volts.

FIG. 2.—MASTER RELAY PANEL FOR BENJAMIN [illegible]

We also illustrate a master relay panel, which [illegible] operate signals from [illegible] The [illegible] operated by current from the lighting circuit [illegible] circuit of the relay is low voltage [illegible]

[illegible]

CONTINUOUS CURRENT MOTORS.

A list No. 22[illegible] [illegible] Houston Co. (Ltd.) [illegible] of the protected and [illegible] type. [illegible] enclosed [illegible] tilating openings in the frame covered with [illegible] This [illegible] ing the ventilation [illegible] and totally enclosed types [illegible]

[illegible]

[illegible]

RUSSIAN ELECTRICAL PROSPECTS.

[illegible]

of the Revolution and the elimination of Germany. The Russian market was not different from any other European market; its possibilities had to be developed in the same way. At present all exports to Russia were hampered badly by lack of tonnage and distribution facilities. Russian progress was handicapped tremendously by lack of railway equipment.

It seemed to Mr. Oudin that after the war the recuperation of Russia from the ravages of the conflict would be as rapid as that of any nation in Europe. Given a stable Government and a fixed national policy, he believed that Russia would have a very great industrial expansion. Electrical development in Russia would follow lines parallel with those of their own development in the last decade of the nineteenth century. Russia must have capital for development of its industries, and the country which promised the most capital on the easiest terms would be favoured with the corresponding business.

With the people of Russia the Revolution was the great fact, the war was an incident. The situation was improving, because the solid element in the cities and the country was beginning to assert itself.

In speaking of the great stimulus to industry which had been given to Japan by the war. Mr. Oudin said: "Japan appears to be and in reality is to-day a most prosperous country, notwithstanding that it is engaged in war. It is estimated that the war has made 50 millionaires in Japan. The importation of electrical machinery of large size is extensive, and the output of factories of all kinds has practically doubled in the last two years. In many lines the efforts of Japan are confined mostly to meeting internal demands, but when the requirements of its domestic markets are lessened it will be more strenuous than ever in the markets of the world. The results of the war will be of very great advantage to China."

EDUCATIONAL.

University of Leeds.—The Vice-Chancellor (Dr. M. E. Sadler), who is leaving England this month for a visit to India, has issued an interesting statement concerning recent developments in the life of the University.

According to the "Yorkshire Post," the chief characteristic of the developments is the attempt to combine in one institution training in pure science, technology and arts. Of the seven great technological departments, three were unique, viz., those of the textile, fuel and leather industries. Each department had generous benefactors, and each had attached to it an advisory committee, upon which industrialists were in a majority and science was adequately represented. The whole of the technological and scientific departments were working together through a research committee, because the problems affecting each industry were found more and more to involve profound knowledge of many sciences. When a problem came upon the industry that the University was trying to serve, chemists, physicists, engineers and bacteriologists all made their separate contributions. Mr. Sadler said that they had at the University one of the greatest schools of chemistry in the world. In inorganic and organic chemistry, physical chemistry, agricultural chemistry, bio-chemistry, and colour chemistry, it was in the front rank. The technological departments depended for their success on ardent research in pure science and intimate knowledge of the current problems of practical industry, and the aim of the University was to bring these two branches of knowledge into fruitful union.

The other great technological departments were colour chemistry, mechanical, civil, electrical and agricultural engineering, and mining. Chemistry was essential in all of them, and therefore the scientific foundation of the University was the study of chemistry. Dyes, drugs, and explosives were all connected with, and based on chemistry, and it was important to observe how closely related were geology, mining, and the scientific study of fuel and gas, especially in view of the geological [illegible] of coal which were going to be worked by new [illegible] and the development of the use of by-products of coal tar.

"[illegible] technical and general education," said Dr. Sadler, "ought to be [illegible] of social duty and obligation, and the note of University work ought to be not only scientific thoroughness, but human service. Therefore, technological and pure science departments [illegible] with the departments of social study and [illegible] of the University [illegible] to be the serving of any partisan ideal of social progress, but to endeavour earnestly and [illegible] the common good, to give everybody his chance, [illegible]

[illegible] since the war [illegible] depended on [illegible] research. Dr. Sadler [illegible] that research could be carried out and under [illegible] The view was that the University [illegible] and women, and that then the best of them [illegible] of the great indus[illegible] managed by the trade [illegible] from the University. What gave [illegible] had done very little in [illegible] the popular idea of a Uni[illegible] and that when they got [illegible] they were [illegible] he pointed out that [illegible] between pure and applied [illegible] and new develop[illegible] in applied science [illegible] the war, had made it [illegible] with its [illegible] for [illegible] The artificial separa[illegible] and applied science would tend to sterilise both.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date arrived at differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1916 Specifications.

7,304 Davies, W. Lange [illegible] Stames A and Naamlooze Vennootschap de Nederlandsche Therm[illegible] Telephon[illegible] Maatschappij. Electrically controlled clutches. (17/5/16.) 108,871.

12,019 Nicholson, J. W. (Anderson G. N.). Primary electric cells. (24/8/16.) 108,893.

12,044 Crawford, A., & Preston, W. Electrical fuses and parts appertaining thereto. (25/8/16.) 109,072.

12,045 Crawford, A., & Preston, W. Electrical fuse boards or systems. (25/8/16.) 109,073.

12,070 Thokle, O. Mouthpiece for telephone transmitters. (25/8/15.) 101,296.

12,147 B.T.-H. Co. (G. E. Co.) Electric furnaces. (28/8/16.) 108,903.

12,231 Pestarini, G. Induction electric motors. (29/8/16.) 109,087.

12,316 Warsop, T. Trolley [illegible] for electric cars and the like. (31/8/16.) 109,098.

12,350 B.T.-H. Co., Hastings, H. C., & Farmer, H. F. Systems of electric motor control. (31/8/16.) 109,101.

A system of control in which resistance is cut in and out of circuit by means of a controller operating in conjunction with series contactors, so that the short circuit across a division of resistance is completed by contacts on the controller if the current in the operating coil of a series contactor is below a predetermined value at the instant the controller is moved forward to the notch corresponding to that division of resistance, but if the current has not decreased to this predetermined value the short-circuit is subsequently completed, on the contacts of the series contactor when this closes, the arrangement being such that the resistance division is again inserted in the circuit when the controller handle is moved backward one notch, the short-circuit across the resistance being opened on the contacts in the controller.

12,395 Sarnmark, A. U. Means for operating apparatus at a receiving station from a sending station by means of electric pulsations. (7/9/15.) 101,411.

12,514 Compagnie Generale des Etablissements Pathe Freres Phonographe et Cinematographe. Sound reproducing.

12,710 Dunning, C. D. J. Aerials for use in wireless telegraph or telephone systems. (7/9/16.) 109,110.

13,142 Kelway-Bamber, C. Electric battery cells. (15/9/16.) 109,122.

14,041 B.T.-H. Co. (G.E. Co.) Windings of electric inductance coils and other apparatus. (3/10/16.) 109,129.

14,290 Hunter, C. E. & Davis, W. J. Spears for current testing apparatus for electrical appliances. (7/10/16.) 108,940.

14,960 Oulianine, S. Electric selectors. (20/10/16.) 108,949.

15,290 Wade, H. (Mills, H. S.) Electric current rectifiers. (26/10/16.) 108,954.

A rectifier in which a synchronous alternating current motor drives a rectifying commutator, said motor having in its secondary two sets of windings, one of which is short circuited and the other of which receives pulsating direct current from the rectifying commutator, the two windings of the motor being in inductive relation to each other.

15,337 Beaver, C. J., & Claremont, E. A. Electric joint-making washers. (27/10/16, addition to 10,023/16.) 109,142.

15,680 Knox, H., Weston, G. & Barnes, G. W. Locking device for use with magneto-electric machines. (2/11/16.) 108,961.

15,931 Cooke, G. F. Magneto-electric machines. (7/11/16.) 108,967.

16,518 Mason, C. T. Interrupters for ignition dynamos. (19/6/15, divided application on 8,584/16.) [illegible]

18,506 B.T.-H. Co. (G.E. Co.) Electric incandescent arc devices. (27/12/16, cognate application, 18,507/16.) 109,188.

1917 Specifications.

177 Mellersh-Jackson, W. J. (Phillips-Brinton Co.) Contact maker and interrupter for electric ignition systems. (4/1/17.) 109,193.

7,636 Giles, G. Apparatus [illegible] electric installations. (27/5/16.) 107,008.

VOLUNTEER NOTICES.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

Headquarters: [illegible] street, Oxford street, W. 1.

Orders for the Week.

Lt.-Col. C. B. [illegible], V.D., Commanding.

Officer for the Week.—Sec.-Lieut. P. Bowden.

Next for Duty.—Sec.-Lieut. E. A. Ullmann.

Promotions.—No. 2 Company—Sapper Tackley, W. A., to be Company Quartermaster Sergeant. No. 3 Company—C. S. M. Rodger, J., to be Company Quartermaster Sergeant; Sgt. Jantzen, P.H.H., to be Company Sergeant Major; Staff-Sgt. Nelson, A. M., to be Drum Major. (24/9/17).

Monday, October 8th.—Drill and Elementary Bridge Construction for No. 3 Company 6.30. Left Half Company. Signalling Class, 6.30. Recruits' Drill, 6.30.

Tuesday, October 9th.—Headquarters Closed.

Wednesday, October 10th.—Drill and Elementary Bridge Construction for No. 1 Company, 6.30.

Thursday, October 11th.—Drill and Elementary Bridge Construction for No. 2 Company, 6.0. Signalling Class, 6.30. Ambulance Class, 6.30.

Friday, October 12th.—Drill and Elementary Bridge Construction for No. 3 Company, 6.30. Right Half Company.

Sunday, October 14th.—Commandant's Parade for work at Esher. Parade 8.45 Waterloo Station, opposite No. 10 platform. Uniform, haversacks, water bottles. Midday rations to be carried. Compulsory for "A" and "B" men.

Musketry.—The range at Belvedere road will be open every Tuesday, Wednesday and Thursday evenings, from 5.30 to 7. All N.C.O.'s and men who have signed the "A" and "B" agreements are required to attend during the month to re-classify in order to enable the Corps to obtain the Capitation Grant. Preference will be given to [illegible] men in training. This does not apply to those who hold the proficiency badge.

Armlets.—The new [illegible] armlets can now be obtained at Headquarters, and every enrolled Volunteer must obtain one without delay. At the same time all old [illegible] armlets must be returned. Armlets must be worn when attending drills in plain clothes.

Medical Examination.—The Medical Officer will attend at Headquarters for this purpose every Thursday at 6.


Osram
G·E·C
DRAWN WIRE
Lamps
OSRAM
PATENT
G·E·C
MADE IN ENGLAND
MAKE
SURE
IT'S AN
OSRAM

COMMERCIAL & INDUSTRIAL SECTION.

Government Control of Trade.

The [illegible] Purposes Committee of the Birmingham Chamber of Commerce [illegible] supplementary report on Government Control of Trade [illegible] that during the vacation a special meeting of export merchants [illegible] metal merchants was held to consider the serious position caused by the Government methods in controlling trade [illegible] recommendations (approved by the London Chamber of Commerce) [illegible] adopted with slight amendment.

[illegible] addressed a letter to the Prime Minister, the Chancellor of the [illegible], the First Lord of the Admiralty, the Secretary of State for War, the President of the Board of Trade and the Minister of Munitions stating [illegible] view was that the Government should not act as a trading intermediary until the resources of existing commercial machinery [illegible] are found to be insufficient; that to this end merchants should be encouraged to continue to carry or import stocks of commodities [illegible] to this country; that so far as any control of imports and [illegible] concerned the quantities allowed should be based as far as possible [illegible] a fair allocation of quantities amongst merchants dealing in particular articles after consultation with representative trade organisations; and that the various control departments (assisted by representatives [illegible] nominated by their respective trades) should be co-ordinated so far as to secure a uniform system on questions of principle and to [illegible] delays in dealing with licences and permits.

[illegible] has been adopted by the council of the chamber.

* * * *

Decimal System of Coinage.

[illegible] members of the Chartered Institute of Secretaries were recently invited to express their opinions in regard to the adoption of a [illegible] system of coinage in the United Kingdom and the substitution of the metric system for the existing weights and measures.

Of the [illegible] received, 85 per cent. considered that a change to a [illegible] of coinage would be favourable to the business in which they were engaged, whilst 66 per cent. favoured a £ basis of coinage in [illegible] to the "Imperial Crown" or dollar basis. In regard to weights and measures, 86 per cent. favoured a change to the metric system, 53 per cent. of whom already used that system in their business. [illegible] were of opinion that the metric system not only [illegible] internal office work but had led to extended business [illegible] with other countries, including France, the United States, [illegible] and the Argentine. In 61 per cent. of the replies the business of [illegible] was stated to be hindered by the use of the existing system of weights and measures.

* * *

State Participation in Industry.

In a lecture recently delivered in the Sheldonian Theatre, Oxford, Mr. H. Wilson Fox, M.P., discussed the question of State participation in industry.

In the course of the lecture Mr. Wilson Fox said: "If we are to [illegible], especially in the tropical [illegible] that the State should play a far more [illegible] in the organisation of [illegible]. It must, in fact, make a new start in these matters. [illegible]

* * *

New Zealand's Electrical Trade.

H.M. Trade Commissioner (Mr. [illegible]) reports [illegible]

[illegible] batteries, bells, &c. [illegible] therefore be wise if they give due place to [illegible] of New Zealand [illegible]. There is a natural disposition to purchase British [illegible] effort should be made by exporters to [illegible] for expanding the trade with New Zealand [illegible].

* * * *

Japan as an Electric Lamp Exporter.

Prior to the war the [illegible] lamps was Germany, but [illegible] the greater part of the German [illegible] foreign lamp trade of an annual value of from 3 million to 5 million dollars was thrown upon America.

[illegible] United States have [illegible] $500,000 [illegible] same time the Japanese manufacturers [illegible] lamps in 1916 amounted to $335,000 [illegible] the current year to $420,000, or at the [illegible] year. [illegible] of $550,000 [illegible] Japanese [illegible] constructed, and the Japanese [illegible] to supply their own filaments.

The progress [illegible] has been very great. With the modern factories [illegible] in the Japanese lamp industry.

* * * *

Canada's Mineral Wealth.

[illegible]

ELECTRICITY SUPPLY.

EXTENSIONS.

Blackpool.—The question of putting in a motor generator and switchgear at the electricity works is being considered by the Electricity Committee.

Bolton.—The Electricity Committee are considering the question of carrying out extensions at the Back-o'-th'-Bank generating station, at a cost of £60,000.

Ilford.—Application is to be made to the Treasury for a loan of £5,792 (at 5½ per cent. per annum) for the electricity undertaking.

The capital is to be repaid in 15 equal annual instalments, the first falling due one year after the termination of the war.

The General Electric Co., whose tender had been accepted for two 250 kw. rotary converters, insisted on the insertion of a clause in the contract providing for the adjustment of the amount in the event of the manufacturing cost being increased as a result of direct instructions by the Government. The Clerk was directed to communicate with the L.G. Board on the matter, intimating that should such an event arise, the Council will anticipate the Treasury reimbursing the Council, the extra cost so incurred.

Kilmarnock.—The Scottish Office has been asked to authorise the borrowing of £80,000 for the extension of the electricity undertaking.

Northampton.—The Northampton Electric Light and Power Co. proposes to extend the supply mains along Castle-street.

Shanghai.—On account of the increasing demand for electrical energy for industrial power, the manager of the municipal electricity department (Mr. T. H. U. Aldridge) will shortly call for tenders for a 15,000 kw. turbo-alternator and condensing plant. By 1920 it is estimated that over 55,000 kw. of plant will be needed to meet the demands for power and lighting.

Southend.—An inquiry will be held on the 14th inst. into the application of the Corporation for sanction to borrow £45,520 for additional generating plant.

Todmorden.—In reply to the Council's application for sanction to borrow £10,000 for extensions of the electricity works, it is suggested that a scheme of linking up with a neighbouring power station would enable the increasing demands for power to be met.

GENERAL.

Board of Trade Electric Power Supply Committee.—Several local authorities which own electricity supply works have already adopted the resolution passed by the Darlington Corporation in regard to the work of the above Committee. The following is the text of the Darlington resolution:

Supply of Electrical Power in the United Kingdom.—It is resolved that representations be immediately made to the President of the Board of Trade, the Parliamentary Secretary of the Board, and also the Member of Parliament for the Borough, stating that it is understood to be the intention of the Government to appoint three members to represent local authorities owning electrical undertakings on the Committee which has been appointed to consider and report on the future supply of electric power for all classes of consumers in the United Kingdom, and that it be urged that the Council is strongly of opinion that such representation is totally inadequate and that the Government be requested to give local authorities at least equal representation on the Committee as is granted to commercial Corporations and private companies owning electrical undertakings.

It is further resolved that the President of the Board of Trade be informed that the Council is of opinion that the local authorities should be permitted to [illegible] their own representatives; and

That a copy of this resolution be forwarded to every local authority in England and Wales owning electrical undertakings, with a request that [illegible] the Council they will take similar action.

Brierfield.—The Urban Council has granted an application by [illegible] for a supply of electricity for power to their [illegible] that they undertake to consume not less than [illegible] from the date of the connection [illegible] the Council.

Brighton.—[illegible] the Controller's [illegible] with the [illegible] South Coast of England.

Chester.—[illegible] has been [illegible] and the [illegible] the duties [illegible] in relation to his [illegible]

Haverfordwest.—The Town Clerk has been requested to ask the Institution of Civil Engineers to name an expert capable of advising on the question of lighting the town by electricity and gas.

Holmfirth.—At its recent meeting, the Urban Council adopted certain recommendations of the Electricity Sub-committee, including one providing that owners of trees which fouled or were likely to foul the supply mains be requested to cut the same.

King's Lynn.—A sub-committee of the Electricity and Waterworks Committee has been authorised to confer with the West Norfolk Farmers' Manure & Chemical Co. as to the supply of electricity to the company's works.

Kinsale.—The Urban Council is considering the question of providing electricity generating plant.

Staffordshire Linking-up Scheme.—Stoke-on-Trent Electricity Supply Committee has instructed the borough electrical engineer (Mr. C. H. Yeaman) to prepare a scheme (jointly with the engineer of Newcastle-under-Lyme) for linking up the Stoke and Newcastle undertakings.

The chairman of the committee will call a meeting between the chairman, vice-chairman and engineer of the committee, and the chairman, vice-chairman and engineer of the Electricity Committee of Leek Council for preliminary discussion of linking-up.

Templemore (Ireland).—At the next meeting of the Urban Council Mr. M'Donnell will move a resolution in favour of the adoption of an electric supply scheme.

York.—The Electricity and Tramways Committee has decided to proceed with the work of erecting lamps and fittings for the electric lighting of part of Hull-road.

HYDRO-ELECTRIC NOTES.

Hydro-Electric Power in Canada.—Three commissioners (Chief Justice Sir W. R. Meredith, and Justices Sutherland and Kelly) have been appointed to investigate and report on the concession of the Electrical Development Co., of Ontario (Ltd.).

The commissioners are to report on the quantity of water in cubic feet per second which the company is entitled to divert or use, the amount of power which it is entitled to generate or develop, the extent (if any) by which the capacity of the works installed or equipped by the company may be developed and the price, terms and conditions upon which the power to the extent of such excess should be delivered to the Hydro-Electric Power Commission of Ontario.

The Commission has been appointed by the Attorney-General of the Province of Ontario, who states that engineers for the Hydro-Electric Commission and the Ontario Government have reported an alleged illegal diversion of water from the Niagara River at Niagara Falls (Ont.) by the Electrical Development Co. and the Canadian Niagara Power Co.

Hydro-Electro Power in India.—"Capital" (Calcutta) says the disappointing quality and quantity of supplies of coal in the North and West of British India have caused consideration to be given to the possibilities of using hydro-electric power as a substitute in industries and undertakings.

The Tata Power Co.'s undertaking which obtains power from the rainfall of the Western Ghats, already provides the mills of Bombay with about 40,000 E.H.P. The undertaking is being extended, and is expected to supply all the power required by the Bombay mills, tramways and Port Trust railway, as well as to provide for the lighting of the city. A capital of two and a half crores of rupees (£1,666,666) is employed in the project.

The hydro-electric plant at Amritsar, recently put in operation by the Punjab Irrigation Department, is a similar project but on a smaller scale. The falls near Amritsar are utilised to generate electricity, which is intended to be used for power as well as for lighting. If the price of Indian coal continues to rise, as is expected, it is also likely that electricity will be generated from coal on a much larger scale than hitherto.

Hydro-Electric Development in Georgia.—The Georgia Railway and Power Co. has submitted development plans to the Georgia Railroad Commission, which will enable it to add 195,530,000 kw.-hours to its generating capacity. The scheme, which is put forward in the interests of fuel economy, the estimated saving in coal being 293,295 tons per annum, will cost about $2,500,000.

Hydro-Electric Plants in Spain.—Mr. Clinton Kearney, an American engineer, is in charge of the erection of a dam and hydro-electric plant near Barcelona.

The concrete dam will, when completed, be the largest in Europe, and will measure 700 ft. long and 330 ft. in height; it has a thickness of 230 ft. at the base and 14 ft. at the top, and the reservoir will be [illegible] miles long and [illegible] wide. Mr. Kearney estimates that it will be at least two years before the big plant of the Ebro Irrigation and Power Co. will be completed, and a large force of Americans will soon be engaged upon the work. One unit generating of 20,000 H.P. has been installed, and another [illegible] will be erected. The plant and construction material will be of American manufacture.

ELECTRIC TRACTION.

Birmingham.—On Thursday last the Lady Mayoress opened a club for women tramway workers.

Councillor Harrison Barrow, chairman of the tramways committee, explained the objects of the club, and said that at present 1,500 women were in the employ of the Tramways Department, whereas two years ago less than 100 were employed. To meet the new circumstances the hours and duties of the tramway workers were so arranged as to provide for the women having a rest in the middle of the day, but that created difficulties for the women, who found they had nowhere to go. That was one reason for the club, which was admirably fitted up for the use of the women. Provision has been made for the serving of refreshments, for reading, writing and music, and they hoped they might have dancing.

Dover.—In consequence of the recent tramway accident at Dover, [illegible] Board of Trade inspector recommends that only single-decker cars should be used on the route on which the accident occurred.

The Tramways Committee has agreed to adopt this recommendation.

East Ham.—The Public Health Committee recommends the Corporation to adopt electric vehicles for dust collection, &c.

Reporting upon the matter, the Finance and General Purposes Committee states that it has considered the question of providing for the purchase of six electrically-propelled dust vans, and having heard the borough treasurer's observations upon the reports submitted to the Public Health Committee recommended that as a considerable saving is anticipated by the use of electric vehicles, that the estimated cost of [illegible] 726 for the purchase of six vans be borne out of revenue account, the [illegible] to be raised by general district rate spread over the next three years.

Leeds to Manchester by Tramcar.—A conference is being called of representatives of the Halifax and Todmorden Corporations, Hebden Bridge Urban Council and the Todmorden Rural Council, to consider a possible linking up between the existing Halifax Corporation tramway terminus at Hebden Bridge, and the terminus of the Todmorden Corporation motor 'buses at Sandbed.

It will be remembered that during the summer many holiday-makers, for reasons of economy, used the tramways instead of the railways for travelling to holiday resorts, and the missing link between Todmorden and Hebden Bridge was found to be very inconvenient. Many [illegible] have [illegible] been made for providing a through service.

L.C.C. Tramway Transfer.—The London County Council has made the following modifications in the arrangements relating to transfer and workmen's tramway tickets:—

Transfer tickets will only be issued for journeys where no through [illegible] run. Passengers who can make their journey without a change are requested to take a through car. Passengers who hold transfer tickets must change at the point indicated on the fare bills; such tickets will not be accepted at other points.

Workmen's tickets will only be available for the second journey between the same points as on the first journey. No change is to be made in the fares charged.

London Electric Railway Workers' Demands.—The programme drawn up by the London Electric Railway Workers' Committee in co-operation with the London District Council of the National Union of Railwaymen, includes:

A 48-hour week, [illegible] day and guaranteed week, minimum rate of 10s. per day, [illegible] for each grade, double time for [illegible] work, overtime, Sundays and Bank Holidays; 21 days' holiday [illegible] with pay, [illegible] with both local and [illegible] representation [illegible] by all grades, [illegible] work [illegible].

London-Watford Electric Train Service.—Various train alterations were made by the London & North Western Railway [illegible] [illegible] withdrawal of the [illegible] service to Watford and intervening stations. [illegible]

Newcastle Tramways and Military Service.—[illegible]

[illegible]

Notts and Derbyshire Tramways.—[illegible]

[illegible]

MISCELLANEOUS.

Electricians' Wages in Scotland.—[illegible] the Electrical Trades Union, workmen's [illegible] mittee on Production in the engineering and [illegible] thereafter.

Inspection of Theatres and Cinema Wiring.—[illegible] of charges was drawn up, the theatre and [illegible] Committee will not sign the certificates [illegible] and without the certificates the Magistrates [illegible] to the Magistrates, again stating that they [illegible]

Prohibition of Exports.—The exportation [illegible] is prohibited on and after Oct. 8.

Wireless Telegraphy for Smaller Vessels.—[illegible]

TENDERS INVITED AND ACCEPTED.

Buildings, &c.

[illegible] lington-street, Wolverhampton.

Electrical Sundries, &c.

[illegible] Birkenhead.

Electric Omnibuses.

[illegible]

[illegible]

APPOINTMENTS VACANT.

[illegible]

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Aberdeen. The accounts of the electricity department for the year ended July 31 show gross capital expenditure £490,613 (increase £27,993), of which £174,781 has been redeemed.

Revenue was £76,994, compared with £76,438 in previous year, ordinary expenditure was £47,215 (£39,180) and casual expenditure £96 (£605), gross profit being £29,153 (£36,692). Interest required £10,993 (£9,717) and sinking fund £18,505 (£18,183), and the net result was a deficit of £345. Units generated were 16,853,240 (15,004,420) and sold 14,087,291 (12,743,835).

In his report the city electrical engineer (Mr. J. Alex. Bell) states that the increased costs were £8,035, including £4,238 increase on coal and £1,276 for capital charges, the latter being due to the increased rate of interest. The department has had to meet considerable increases of load at a time when generation for two important districts was in the transitory stage between alternating and direct current supply. The number of heating and cooking utensils hired out is 1,405. Power units were 9,249,858 (4,692,626) and horse-power of motors connected is 14,028 (8,441). It is estimated that the total power requirements of the area over which the department has powers of supply amount to 33,000 H.P., so that 42½ per cent. of the power required is already supplied by the Corporation. Coal and cartage cost 0·427d. (0·38d.) per unit sold and total costs were 0·761d. (7d.) and capital chargos 0·502d. (0·52d.). Revenue from current was 1·215d. (1·35d.). Everything possible is being done to get the new 5,000-kw. turbo-alternator set installed before the winter load. A 500-kw. converter for York-place sub-station has been delivered, and a 350-H.P. electrically driven pump for condensing water supply is in course of erection.

Hackney (London).—The electricity department's accounts for the year ended March 31 show total capital expenditure £505,169 (increase £1,128), of which £381,334 is outstanding.

Revenue was £88,050 (compared with £66,747 in previous year) and working and general expenses were £50,478 (£42,494), leaving gross profit £37,572 (24,252). Interest on loans required £14,444 and principal of loans £15,586, the amount spent on meters and indicators was £211 (£288), bank interest on overdraft required £576, allowances to officers and workmen serving in H.M. Forces and expenditure for protection of station £1,156 (£1,986), and aircraft risk insurance £305 (£277), the net profit being £5,290. The profit from the sales department was £166 (£772). Average price obtained was 1·34d. (or 1·33d. after allowing for discounts), compared with 1·46d. in previous year; fuel cost 0·51d. (0·5d.) per unit sold, total working expenses were 0·75d. (0·84d.), and total costs, including capital charges, were 1·23d. (1·64d.). Total maximum demand was 7,951 (5,065) kw., and load factor was 21·97 (20·39) per cent. Units generated were 18,033,620 and purchased in bulk 35,800; total 18,069,420 (against 11,417,946 generated in previous year), and sold 15,302,372 (9,071,026). Connections are equal to 511,442 (418,354) 30 watt lamps, including motors equal to 12,370 (8,770) H.P.

The report of the borough electrical engineer and the borough treasurer states that during the year a link with the North Metropolitan Electric Power Supply Co. was arranged, and the work put in hand.

St. Pancras London The accounts of the electricity department for the year ended March 31 show gross capital expenditure £589,575 (increase £15,323), and £190,696 of loans has been repaid. The reserve fund amounts to £51,89[illegible].

Revenue was £130,498 (compared with £98,441 in previous year), and total expenditure was £71,815 (£59,004), leaving gross profit £58,683 [illegible] £3,230 (£56), interest on bank balance, and [illegible] balance brought forward. Interest on loans required £14,604 and on deposits £69, instalments of loans £16,432, [illegible] £222 leaving net profit £27,592 (against £10,337). Units generated were 16,237,007 (13,956,400), and [illegible] maximum supply demanded was [illegible] 4,572 against 4,732 and the [illegible] the following increases [illegible] 1,522 kw., heating and [illegible]

COMPANIES' MEETINGS AND REPORTS.

CAPE TOWN CONSOLIDATED TRAMWAYS & LAND CO. (LTD.)—[illegible]

[illegible] WEST INDIA CABLE CO. (LTD.)—[illegible]

has been debited with £1,350 applied to dividend and with £6,393 expended in repairs and credited with £24,674 surplus revenue of past year, and it now stands at £71,679, subject to excess profits duty.

HALIFAX & BERMUDAS CABLE CO. (LTD.)—The net result of the working for the year ended June 30 is a balance of £19,649. 13s. 11d., compared with £12,745. 10s. 3d. for the previous year. An interim dividend of 3 per cent. (tax free) has been paid, and it is now proposed to make a further equal payment (tax free), which will leave £16,649. 13s. 11d. to be carried forward. The balance to credit of revenue account, which was last year £9,210. 0s. 7d., has been debited with £1,500 applied to dividend and with £2,202. 2s. 3d. expended in repairs, and credited with £16,649. 13s. 11d. surplus revenue of the past year, and it now stands at £22,157. 12s. 3d., subject to excess profits duty. The company's cable has worked efficiently during the year. The directors refer with regret to the death of their colleague, Mr. W. M. Kent, and Mr. H. F. Russell has been elected to fill the vacancy.

MANAOS TRAMWAYS & LIGHT CO. (LTD.)—The report for the year ended April 30 last states that the economic conditions in the Amazon valley did not compare unfavourably with those which obtained during the preceding year, and the result indicates a gradual return of prosperity to the district. The loss on remittances from Manaos was £12,231 against £13,093. The gross earnings from all departments were £120,387, compared with £110,524, while operating expenses increased from £76,172 to £82,511. The net operating revenue increased from £34,352 to £37 876. After providing for debenture interest, sinking fund interest on loan, London office expenses, &c. there remains £6,628. The directors recommend transferring to contingencies reserve £3,000 and to renewals reserve £3,000 and to carry forward £628.

NEW COMPANIES.

ABRAISIVES (LTD.) (148,486.)—Private company reg. Sept. 19, capital £10,000 in £1 shares, to carry on the business of manufacturers, and factors of, agents for and dealers in metals, emery, emery stone corundum, abrasives, mechanical and electrical and general eng neers, &c. First directors are J. S. Mitchell and W. M. Rowland.

AUTO GRAB SYNDICATE (LTD.) (148,493.)—Private company, reg. Sept. 20, capital £500 in £1 shares (250 "A" and 250 "B"). Iron and brass fenders, mechanical and electrical engineers, &c. Agreement with J. M. Wellington and D. G. Mackenzie. Reg. Office: 71, Fleet-street E.C.

BRITISH AUTOMOBILE EQUIPMENT CO. (LTD.) (148,441).—Private company, reg. Sept. 11, capital £100,000 in £1 shares (50,000 7 per cent. cumulative preference), to acquire certain patents and rights (*a*) from Accuratact Magnetos (Ltd.) and H. D. Grant, and (*b*) from H. D. Grant to acquire from F. Lamplough the business of an aviation, motor and general engineer carried on as "Lamplough & Co," and certain lands, plant, &c., and (*c*) to enter into an agreement appointing G. F. Cooke electrical engineer. Reg. office: Finsbury-pavement House, E.C.

CHANGEABLE SIGN (LTD.) (148,536.)—Private company, reg. Sept. 26, capital £5,000 in £1 shares. Manufacturers of and dealers in changeable and other signs, electricians, advertising contractors, &c. Agreement with F. T. Harris. First directors are F. T. Harris and J. C. Taite.

T. B. WATSON & SON (LTD.) (148,546).—Private company, reg. Sept. 26, capital £6,000 in £1 shares, to take over the business of electricians and sanitary and heating engineers carried on by T. B. Watson at Stockton-on-Tees and Middlesbrough. First directors are T. B. Watson and H. C. Watson.

CITY NOTES.

ABERDEEN SUBURBAN TRAMWAYS CO.—The accounts for the half-year ended July 31 show a profit, including £2,011 brought forward, of £3,310, out of which a dividend of 5 per cent. has been declared for the past year, leaving £517 to be carried forward.

CALLENDER'S CABLE & CONSTRUCTION CO. (LTD.)—The directors announce an interim dividend at rate of 10 per cent. per annum on the ordinary shares, for the half year, payable Nov. 1. A year ago the interim dividend was at the same rate.

KALGOORLIE ELECTRIC POWER & LIGHTING CORPN. (LTD.)—The directors have declared a dividend on the preference shares at the rate of [illegible] per cent. per annum for the [illegible] months ended 30th ult.

MARCONI INTERNATIONAL MARINE COMMUNICATION CO. (LTD.)—Allotment letters in respect of the issue of 250,000 new shares have been posted. The issue having been largely over applied for, applicants received an allotment equal to [illegible] of their holding, applications for less than that proportion being allotted in full.

NORTHERN GENERAL TRANSPORT CO. (LTD.)—An interim dividend [illegible] per cent. per annum [illegible] per share), less tax, has been declared on the ordinary shares.

ORIENTAL TELEPHONE & ELECTRIC CO. (LTD.).—The directors deny the statement that [illegible] of the Company's Egyptian property or [illegible] have been [illegible] with the Egyptian Government, with whom they are in negotiation.

THE ROUND TABLE.

By "KVA."

THE LATEST PEACE KITE.—The Langdon Davies Motor Co. recently received the following telegram :—

B. N. LANGDON-DAVIES, LONDON.

Will you speak at Ammanford 24th with Mr. Snowden, wire reply.

I can imagine what Mr. P. F. Brittain answered, but how do these slurs come to be cast on the electrical industry.

* * * *

The Electro-Harmonics will commence on Oct. 12, and there will be no [illegible] how different last year! The Concert tickets this year are doubled in number, one for the member and one for the visitor. Does the Society know there is a shortage of paper?

* * * *

"Electricity on tap at the Kerbstone," says a headline. [illegible] very nice too, but ask any wireman, shift engineer or [illegible]-man of turbo-generators where his preference lies.

* * * *

A reader who has just returned from holiday on the West Coast of Ireland, tells me that in one village through which he passed, three clocks showed three different times, "Irish" [illegible] time, and sun time. It would need the genius of a Hope-Jones to synchronise these Irish!

* * * *

From "London Opinion" [illegible]

[illegible] "Don't you know its against orders to take [illegible] What the blazes were you in civil life?"

[illegible] "In a draughtsmen's office, sir."

[illegible] "Draughtsman, eh? What would you say if I [illegible] into your office and punched some of your draughts?"

* * * *

In "[illegible] Life," under the title of "Suppose the war [illegible] the year 19[illegible]," Arthur Wright from "Blighty" [illegible] obstacles to the smooth working of their con[illegible] the American people will have to face and [illegible] the Allies have already tackled. Numbers 9, 12 and 13 [illegible] appeal to Round Table readers:—

[illegible] The [illegible] of the irritatingly slow system of priority [illegible] of A, B and C classes for most materials and apparatus [illegible] in such trades as Public Utilities.

(12) The continual changing of Government regulations and of the personnel of many of its departments, due to the weeding out of the inevitable inefficient officials.

(13) The alarming army of newly created Government officials and inspectors, and their frequently arbitrary decisions, with the vexatious overlappings and contradictions, consequent of their hasty selection, and their utter disregard of all ordinary business canons of procedure.

* * * *

THIRTY-SEVEN YEARS AGO.

(From THE ELECTRICIAN, October 2, 1880.)

SELENIUM.—If the specific resistance of pure copper be taken as unity, that of selenium is about 3·8 by 10^{10}, or thirty-eight thousand millions.

OVERHEAD WIRES.—An American contemporary thinks that while overhead wires are dangerous in one way, they may in another [illegible] be preservatives against [illegible]

THE ILLUMINATION OF [illegible] CENTRAL PARK AT NEW YORK.—It appears certain that the [illegible] light will be employed for lighting the park, which [illegible] at night a refuge for [illegible] and malefactors. It [illegible] that the laying of [illegible] would necessitate the [illegible] of the roots of a large number of trees, and that the [illegible] them would be most [illegible] to the plants and shrubs [illegible] light would not only be free from these objections but [illegible] considerably cheaper.

[illegible]

[illegible] "At one time for 48 hours the wires [illegible] to cool."

Electricity in Oil Works. In the [illegible] Petroleum [illegible] it is stated that the [illegible] by the [illegible] oil-fired [illegible] in the current year owing to the higher price of crude oil, [illegible] should [illegible] whenever [illegible] labour [illegible] naphtha [illegible] an advance in [illegible] per [illegible] the workmen [illegible] advices from [illegible] interest, and [illegible] every branch [illegible]

Road Board Report. [illegible] Board for the year ended March 31 [illegible]

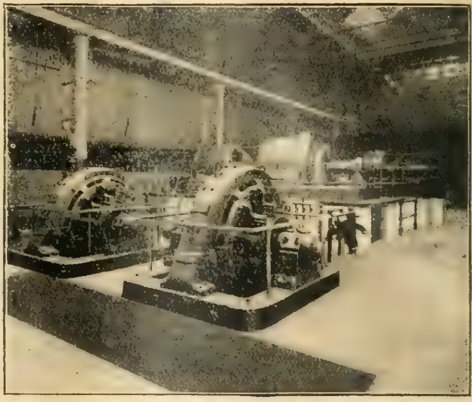
During the year ended March, 1917, [illegible] over £1,050,000, [illegible] road construction [illegible] county roads suitable for such treatment.

[illegible] the local authorities is est[illegible] of £[illegible]

Staffordshire's Mineral Resources. [illegible] fact had never been [illegible]

FACTORY ELECTRIFICATION.

The practice of generating continuous-current by the use of turbo-alternators coupled to rotary convertors is rapidly extending, and one of the numerous installations of this description laid down by the General Electric Co. is depicted in the illustration. This plant is installed in an important engineering works, and comprises a 1,500 kw. "Witton" turbo-alternator, running at a speed of 3,000 r.p.m. and generating six-phase alternating current which is delivered to two 750 kw. "Witton" rotary converters running at 600 r.p.m. and generating continuous-current at 460 volts. The installation has proved completely satisfactory, and has again demonstrated



the utility of this method of generating continuous-current which enables the turbine to be run at a high speed of 3,000 r.p.m. by which the highest efficiency is attained, while at the same time the continuous-current commutators on the converters can be designed with a peripheral speed consistent with satisfactory working. In the background of the illustration a 750 kw. "Witton" continuous-current turbo-generator set is seen which has now been running for over 10 years. This type of machine is now superseded for the generation of continuous-current by the combination described. The complete installation was laid down by the General Electric Co. (Ltd.), of Witton, Birmingham, and Queen Victoria-street, E.C. 4.

VICTORIAN RAILWAY ADMINISTRATION.

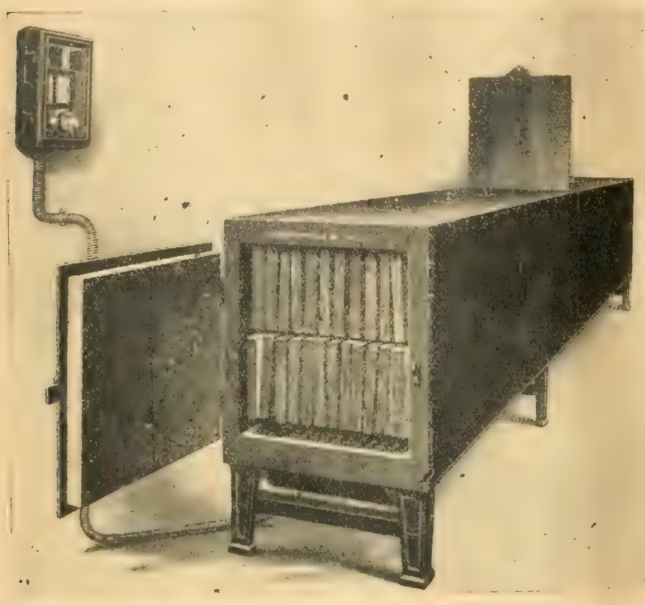
Mr. J. R. Johnson, the special commissioner appointed to report upon the management of the Victorian Railways, has issued his final report.

He says the railways are administered with due regard to economy, efficiency and the public convenience, having regard to the abnormal conditions of the past three years, and the deficits in the accounts have been brought about largely by influences beyond the control of the Railway Commissioners. The construction of new railways should be suspended and on lines in course of construction expenditure should be reduced to the lowest limits. Interest should not be charged against the railways until an appreciable part of the lines is in operation. Capital charges should be spread over a further period of 10 years. The evidence taken did not disclose any particulars of over manning or defects in management. The causes of financial retrogression in recent years were increase in wages, increased cost of coal and other materials, increased interest charges. Even if capital expenditure were to remain stationary, the conversion of loans at a higher rate of interest would increase the interest charges during the near future. If the finances of the railways as a business concern were to be placed on a satisfactory basis, a considerable increase in fares and freights was necessary.

The electrification of suburban railways has resulted not only in increased interest charges but also in heavy charges to working expenses on account of alterations to bridges and rolling stock. As the electrification was entered upon as a matter of State policy, the railway finances should be relieved of the annual interest charges upon the capital expended until at any rate, an appreciable part of the work is in actual operation and revenue producing. Another factor contributing to loss on the railways during recent years is the competition brought about by the operation of electric tramways in the suburban area which has resulted in an annual loss of about £60,915. It is undesirable that sanction be given in future to the construction of electric tramways which will unduly compete with the suburban railway system.

AN ELECTRIC TIMBER DRYING OVEN.

The illustration shows an electrically-heated oven which is used for drying timber as received from the yards. The overall dimen-



sions of this oven are 16 ft. 6 in. by 3 ft. 5 in. back to front by 3 ft. 7 in. high, the whole apparatus being mounted on 12 in. cast-iron legs. It comprises a heavy angle iron framework, with a housing of steel plate: the oven is double cased and packed throughout with 2 in. of heat-insulating material. An insulated steel plate door is fitted at each end of the oven, and when only half the oven is required a steel plate is fitted which may be raised or lowered through a slot, the plate when lowered forming two separate ovens. This dividing plate, if required, may be balanced by a counterweight fitting. Each compartment is fitted with a thermometer for ascertaining when the required temperature is reached, and it is found by experience that approximately 140 F. is most suitable, although for different classes of timber this temperature may be varied. The full loading of the timber dryer is 8 kw., the heat regulation being controlled by heat regulating switches giving six heats, mounted in a cast-iron box, together with fuses and luminous indicators. To facilitate placing the bulks of timber to be dried in the oven, a set of 16 in. steel barrel rollers is fitted in the bottom of the oven, and immediately under these checker or radiating plates are placed for protecting the heating elements and for giving an even heat. The heating elements are fixed immediately under these plates the whole length of the oven. To give even heat regulation, three-heat control is arranged for each compartment. When first starting up it is necessary to switch on to "full," and when the required temperature is reached for normal working the switch is moved to "low."

For ventilation, six circular disc hit-or-miss ventilators are provided in the roof of the oven, and these can be adjusted as required. All the connections are carried out to a terminal box through cast-iron channel ducts, and thence from the terminal box to the cast-iron switchbox mounted on the wall adjacent. The wires from the terminal box to the switchboard are protected by flexible metallic tubing.

This electric timber dryer, which was supplied by Messrs. Cromp-

ton & Co. (Ltd.), is installed in the works of Messrs. Fraser & Chalmers (Ltd.), of Erith, Kent, and since its installation, which is now about three months, has been found eminently satisfactory.

ELECTRIC ENAMELLING OVENS.

An interesting and economic application of electric heat to the art of enamelling may be seen at the Ford Motor Co.'s assembling plant in Chicago, where there is an installation of 108 electric heaters in the main enamelling oven, by which a temperature of 450° F. to 475°F. is maintained. The enamelling department, comprising dipping tanks, oven and accessories, is on the sixth floor of the main building. The oven is built in two sections, consisting of a preheater and principal oven. The size in cross-section is 7 ft. 1 in. in height by 4 ft. 4 in. in width, inside measurement. The length of the main oven is 79 ft. 8 in., inside; the length of pre-heater is 30 ft. The oven structure is of sheet iron, supported by a steel frame, with heavy asbestos linings, making walls 6 in. thick.

The oven proper contains 108 220-volt, three-phase, heating units, aggregating 160 kw. These consist of nichrome ribbons, mounted upon porcelain insulators. The heaters are arranged along the floor and both sides of the oven chamber for a distance of 40 ft., and this part of the oven is called the heating section. Current, which is supplied by the Commonwealth Edison Co., is brought in through bus bars and asbestos-covered wires. The temperature of the heating chamber is maintained between 425° and 475° by an automatic controller, acting upon an auxiliary contactor, controlling 24 heaters. The consumption of current by the 108 heaters amounts to 125,000 kw.-hrs. per month.

The metal parts being enamelled, are first dipped in a 200-gallon tank of asphaltic enamel, then hung by hooks upon an endless-chain conveyer, which is carried by a sprocket wheel at each end in the top of the oven. This conveyer makes a continuous circuit, for instance, carrying a metal part first through the pre-heater then by a semi-circular turn into, and through the main oven, thence by another turn to the starting-point, where treated parts are taken off and those to be treated are hung upon the conveyer. This loading and unloading place is an open space, outside the ovens where the dipping tanks are situated. The sprocket wheels, on which the chain conveyer rides, are driven by a 3-H.P. variable-speed motor, stationed on top of the oven. The speed of the conveyer is 18 in. to 36 in. per minue. Metal parts are dipped in enamel and carried around the circuit, then taken off and dipped a second time and passed through the ovens again; and at the end of the second circuit the enamel is absolutely dry and hard and the parts are ready for assembling. The temperature of the pre-heater is maintained at 225°. Ventilation of the ovens is regulated by two 15-in. smoke stacks at different points in the roof; and by a rotary suction fan, driven by a 1 H.P. motor, pipes at the entrance end of the oven. Each day's run of metal parts through the enamelling ovens amounts to 50,000 lb. to 60,000 lb. per 24 hours, at a cost of 6·7 kw.-hr. per 100 lb. This material is made up of 12 different kinds of parts, and the equipment is ample for the enamelling required in the assembling of the 72,000 automobiles turned out in one year. By the use of electric enamelling ovens there is a pronounced saving in labour costs, as compared with those costs when gas-heated ovens were used. It is understood that with electric ovens the labour costs are only about two thirds as much as when gas ovens were in use. Another phase of economy is the speed of operations and the uniformity and steadiness at which heat may be maintained. The run of the circuit through the ovens requires only 30 to 40 minutes.

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CONTENTS.

NOTES.

A Scheme of Reconstruction.

When a subject of national importance has been considered by a committee, and definite recommendations have been made, there is always the danger that nothing further will be done because it is not the business of any body in particular to take the matter in hand. On the subject of industrial reconstruction a great deal of discussion has now taken place. Prof. KIRKALDY dealt with the question in his Presidential Address to Section F of the British Association last year; the whole subject was discussed in the memorandum issued by the Garton Foundation; organisation and co-operation have been urged in the report of the Advisory Council of the Privy Council Committee for Scientific and Industrial Research; and lastly, Joint Standing Industrial Councils were recommended in the Whitley Report. It still remains, however, for something definite to be done. It is with the object of securing some action that a manifesto, which we publish in another column, has now been issued. It is signed by many people of note, and we do not think that any exception can be taken to the main principles which are therein laid down. It is, for example, essential for national prosperity that there should be greater co-operation between manufacturers, that there should be co-operation between labour and capital [illegible] avoiding industrial strife, that every trade should present a united front to foreign [illegible] and that encouragement should be given by the Government to the activities of trades, but with a minimum of interference. The present manifesto may be looked upon as an expression of a genuine desire for co-operation with labour, and it is significant that it bears the signatures of many manufacturers and officers of employers' associations. It may well be that in questions of detail the manifesto does not represent a [illegible] final [illegible]. This, however, is comparatively unimportant. The important point is that something should be done, and that [illegible] body of reconstruction should be carried out [illegible] so that tangible results may be obtained.

An Example of Interlinking.

It is not often that we are able to publish [illegible] of the interlinking of [illegible] power [illegible]. In the present issue we publish an account of this kind, showing the advantages that may be obtained. The present scheme concerns three towns in the United States. These are Salem, with a capacity of 1,700 kw.; Malden, with a capacity of 3,400 kw.; and Revere, with a capacity of 1,000 kw. The station at Salem was in the position of having a large reserve of power; that at Malden was overloaded, and the station at Revere was loaded up to about three-quarters of its capacity. Under ordinary circumstances it would have been necessary to make considerable extensions at the Malden power station. Instead of doing so, however, overhead interlinking mains were run, so that all power in excess of normal requirements could be supplied by Salem to the other two stations. To some extent the diversity factor of the loads assisted the obtaining of a good result, though the effect was not so marked as it probably would be in [illegible]. The actual results have proved to be very satisfactory. The interlinking mains are owned by a separate company, which, therefore, looks for a profit on the part of the scheme. The financial results show that this company made a profit of [illegible]; the Salem Company profited to the extent of [illegible], whilst the Malden Company saved [illegible] and the Revere Company made a saving of [illegible] in the year. [illegible] the total advantage of this interlinking [illegible] £4,100 in the first year.

British and Foreign Steel Manufacture.

At the recent meeting of the Iron and Steel Institute [illegible]

[illegible]

advantage is more problematical. This, like the smelting and metallurgical industries, is evidently a case where cheap electric power is a very important factor.

A Bureau of Standards for Birmingham.

LAST week Prof. F. W. BURSTALL delivered an address before a meeting of the Midland manufacturers on the establishment of a Bureau of Standards of Length for the Midland area. He pointed out the very great importance of the correct measurement of length and the testing of gauges, &c., on which depends all the mechanical engineering work that is carried out in this country. Undoubtedly the subject has come forward prominently during the present war, and if manufacturers go in for standardised products, as they should, the subject will be still more important in the future than in the past. The only difference between one branch and another in mechanical engineering is that the standard of accuracy in one branch is necessarily higher than it is in another; but in every case it is essential that certain limits of accuracy should be laid down if the product is to be satisfactory. It is true, as Prof. BURSTALL states, that no great amount of costly plant would be required to set up such a laboratory. While agreeing in general terms with the statements made by Prof. BURSTALL, we feel there is an objection to the proposal in that we already have the National Physical Laboratory for carrying out such measurements. It may very well be that it is inconvenient to send gauges from the Midlands to Teddington for the purpose of testing, but if this inconvenience is felt to be sufficiently serious we think the general principle should be followed of setting up local laboratories as branches of the National Physical Laboratory, so that they would be under one common direction and the same recognised methods would be followed at all centres. We feel it would be a mistake to set up a number of independent laboratories at various centres; but there can be little objection to having branches, as it were, of the National Physical Laboratory, if the need for having such branches is clearly proved.

Municipal Tramways Association.—At the annual conference at Blackpool on the 21st ult., Ald. Flint, chairman of the Leicester Tramways Committee, was elected president for the ensuing year.

Monument to Dr. A. Graham Bell.—It is stated that a monument will shortly be unveiled at Brantford (Ont.) to Dr. Alex. Graham Bell, inventor of the telephone, to commemorate his invention. Dr. Bell, who was born in Edinburgh in 1847, went to Canada in 1870, and brought out his patent while living at Brantford in 1874.

Some Industrial Developments in Japan.—Prof. H. [illegible] in "Chemical [illegible]," has given some interesting notes on recent industrial developments in Japan. The Japanese [illegible] Co., which is subsidised by the Government, and the [illegible] Co., and Mitsui Mining Co., all of which are [illegible] are said to be obtaining good results. As about 12,000,000 lb. of [illegible] are required in Japan annually there is ample scope for such efforts. Medicinal chemicals and [illegible] products such as alcohol and [illegible] [illegible] and phosphorus are also now being produced. Japanese paper manufacturers are also reported to have been doing good business, especially with India and Australia, and there has been great expansion in the paper industry.

The Electrical Conductivity of Thin Films of Metal.—In the "Physical Review," Mr. R. W. King points out that it has long been known that the specific resistance of very thin films of metal is abnormally high. Such films of gold and silver show a granular structure when examined by a "dark field" microscope, whereas thicker films appear uniform. No such appearance could be observed with platinum, but it is thought that this is due to the limitations of the microscope. It has been found that, in order just to conduct, platinum films must be between $1{\cdot}5\mu\mu$ and $3\mu\mu$ thick, gold and silver films between $6\mu\mu$ and $8\mu\mu$ thick. It seems doubtful if particles of this thickness can be detached from a cathode by bombardment, and their formation is probably due to the condensation of atoms of the metals. Reasons are given for rejecting the theories of Thomson and Swann relating to the conductivity of thin films, and the author deduces a relation between conductivity and thickness based on the supposition of a more or less random arrangement of groups of atoms.

"Artificial Daylight" as an Addition to Natural Illumination.—In a recent discussion before the American Illuminating Engineering Society some special types of electric lamps were described, including several of the gas-filled blue bulb lamps intended to simulate the colour of daylight. The use of the gas-filled lamp enables a considerably higher efficiency to be attained in such lamps than would be possible with ordinary vacuum units. It was remarked in the course of the discussion that in portions of a very large number of industrial buildings the natural lighting is insufficient during a great part of the day, and requires to be supplemented by artificial light. It is, however, well known that daylight and the light of ordinary incandescent lamps cannot conveniently be "mixed." The eye appears to be able to accommodate itself to either form of light separately, but dislikes the effort involved in simultaneous adaptation to both varieties. It was, therefore, suggested that if "artificial daylight" units were used in the darker regions of such buildings the inconvenient colour transition from daylight to artificial light might be avoided.

New Industrial Developments in France.—An exhibition, organised by the "Société d'Encouragement pour l'Industrie Nationale" last June, to which reference is made in the "Engineer," shows that France has been very active in replacing by its own manufactures many materials previously imported from abroad. At this exhibition, it is stated, chemical glass and quartz ware formed an important section. Several firms have been endeavouring to produce good heat-resisting glass of the Jena variety, and appear to have obtained encouraging results. The same applies to chemical and scientific glass ware, Coolidge tubes and radiographic apparatus. Also of interest are the exhibits of earthenware vessels for holding acids, while chemistry was well represented by exhibits of many organic and coal tar derivates required in the manufacture of explosives. Progress has also been made in the manufacture of various rare earths, such as cerium, ferrocerium, and magnesium, which in peace time came almost exclusively from Germany. We gather that there were not many engineering exhibits, but evidence of development was also afforded in such matters as machine tools, small electric motors and magnetos.

Brass Furnaces and Fuel Economy.—At the autumn meeting of the Institute of Metals, Mr. L. C. Harvey gave some striking figures illustrating the possibilities of economy in the use of fuel. He estimated that during 1910 the amount of coal mined in the world was about 1,300,000,000 tons, and of this vast amount probably not more than 5 per cent. was actually turned into useful work. Thus, 1,235,000,000 tons of coal were wasted by heat radiation and other losses. There were special opportunities for economy in the melting of brass, which was being used in enormous quantities for such purposes as fuse rod and cartridge strip. The uneconomical coke-fired crucibles, so largely used for melting brass, had only an efficiency of 2.6 per cent. Assuming that the output of brass for such purposes as the above was 2,000,000 tons in 1916, the amount of coke required to melt this quantity of metal in small pit furnaces with a 5 per cent. efficiency would be about 800,000 tons, of which about 760,000 would be wasted in radiation, &c.; the value of the fuel thus wasted would exceed £1,000,000. Assuming, however, that the more economical tilting furnaces now being developed were employed, this consumption of fuel could be reduced to about one-third of the above figure.

British Engineering Standards Committee.—Anglo-American Co-operation.—The American Institute of Electrical Engineers have very cordially accepted the Committee's invitation and have appointed Mr. H. M. Hobart, M.Inst.C.E., M.I.E.E., as the delegate of their Standards Committee to confer with Sir Richard Glazebrook's Panel Committee on the standardisation rules for electrical machinery, and it is a pleasure to be able to announce Mr. Hobart's safe arrival in this country. The chairman of the British Engineering Standards Committee, Sir John Wolfe Barry, K.C.B., and Sir John Snell, chairman of the Sectional Electrical Committee, will welcome Mr. Hobart on Wednesday, Oct. 17, the first day of the Rating Conference. Moreover, Mr. Hobart's presence in England will afford an opportunity for consultation in regard to the standardisation of electrical apparatus generally, in connection with which much work is being carried out by various Panels of the Committee, especially in respect of motor starters, ship's fittings, fuses, instruments and instrument transformers, under the direction of Mr. C. H. Wordingham. As on the previous occasion, at the Rating Conference, the Canadian National Committee of the International Electrotechnical Commission, have invited Mr. A. P. Trotter to represent them.

Faraday Society.—General Discussion on "Pyrometers and Pyrometry."—A General Discussion on "Pyrometers and Pyrometry" will be held on Wednesday, Nov. 7, 1917, at 8 p.m., in the Rooms of the Royal Society of Arts, John-street, Adelphi, London, W.C. 2.

Sir Robert Hadfield, Bart., F.R.S., President of the Society, will preside over the Discussion and deliver an Introductory Address. Dr. E. F. Northrup (Trenton, N.J.) will send in a communication entitled "High Temperature Production and Its Measurement"; Dr. Ezer Griffiths and Mr. F. H. Schofield, B.A., B.Sc. (National Physical Laboratory), will read a Paper on "Pyrometer Standardisation"; Mr. R. S. Whipple (Cambridge) will read a Paper on "The Advantage of Burying the Cold Junction of a Thermo-couple as a means of Maintaining it at a Constant Temperature"; Mr. Richard P. Brown (Philadelphia) will read a Paper and give a Demonstration on "The Automatic Control Measurement of High Temperatures"; Prof. J. O. Arnold, F.R.S. (Sheffield), will speak on "Pyrometry Applied to the Hardening of High Speed Steel"; Mr. Cosmo Johns (Sheffield) will speak on "Determining the Temperature of Liquid Metals by Means of Optical Pyrometers"; Dr. W. H. Hatfield (Sheffield) will read a Paper on "Pyrometry from the Standpoint of Ferrous Metallurgy"; Mr. H. Watkin (Stoke-on-Trent) will read a Paper on "The Measurement of High Temperature by Means of Pottery Material"; Mr. C. R. Darling will read a Paper on "Base-metal Thermo-electric Pyrometers"; Dr. J. W. Mellor, Mr. F. Twyman, and Mr. G. E. M. Stone will also contribute to the Discussion. A number of instruments will also be exhibited.

OBITUARY.

W. R. Sykes.—We regret to record the death of Mr. W. R. Sykes, the inventor of the system of interlocking the block instruments and the outdoor signals on railways, and controlling the block instruments by the movements of the trains, which took place at his seaside residence on the 2nd inst.

Mr. Sykes was born in 1840, but, owing to the death of his father, had to go to work at the early age of 14 years. One of the first places he went to was the Electric Telegraph Co., where he served under Latimer Clark, Edwin Clark, C. F. Varley, and S. A. Varley, whilst at night he was working for Shepherds, the [illegible] makers. In 1863 he went to the telegraph department at Victoria of the London, Chatham & Dover Ry., and within the next two years he [illegible] and installed an electric repeater for telling a signalman [illegible] of a signal that was [illegible] [illegible] The former was fixed at Herne Hill and the latter at Brixton. [illegible] [illegible]

that it is impossible to open the bridge should [illegible] and, vice versa, impossible to accept a train [illegible] bridge [illegible] siderable attention at the hands of Mr. Sykes. [illegible] bridges he so protected were the Hawarden, Selby, [illegible] Newcastle [illegible] Penge tunnel an electrically-operated [illegible] Victoria terminus of the London, Chatham [illegible] operated shunting signals [illegible] and were interlocked with the point levers, and all [illegible] were provided without [illegible] become very popular since then, as they can be ad[illegible] nalling at a minimum of expense. This led to the a[illegible] system of electro-mechanical [illegible] Glasgow & South Western Ry.'s St. Enoch [illegible] the London, Brighton & South Coast Ry., Victoria station. [illegible] former there are six signal boxes which contain [illegible] levers and 590 signal slides [illegible] contains 488 levers, and is the [illegible] number of [illegible] may be judged from the fact that the 100 levers in [illegible] go into a length of 12 ft. [illegible] aggregate of 176 point levers, and 353 signal slides, [illegible] When speaking of large termini, mention should [illegible] important work done by Mr. Sykes in connection w[illegible] in 1892 of the London & South Western [illegible] Here was provided electrical apparatus, mu[illegible] in order to meet some local conditions, for [illegible] fouling bars, detectors, replacers, wrong-road [illegible] of conditions—besides the equipment of "l[illegible] to say that it was the work at Waterloo that [illegible] name as the leading authority as to the use of [illegible] nalling. Although the Sykes' system was to be f[illegible] railways [illegible] of that company until its amalgamation with the S[illegible] [illegible] which position he held up to his death.

Deaths on Active Service.—[illegible] Flight Sub-Lieut. J. D. Grant, R.N., who has been drowned at sea as [illegible]

PERSONAL.

[illegible] ment by rotation of Mr. W. [illegible]

War Honours.—The foll[illegible] the Military Medal [illegible]

ARRANGEMENTS FOR THE WEEK.

Friday, Oct. [illegible]

ELECTRIC WINDING.*

BY PROF. D. BURNS.

The capacity of a winding engine depends on (1) the output to be raised per day, (2) the depth of the shaft and (3) the inertia and acceleration stresses to be overcome.

Considerable discussion has centred round the possibilities of using electric winders in place of the more familiar steam engine. Such discussion has hinged on (1) the relative merits of the two types of winders, having regard to their reliability and ease of control, and (2) whether the electric winder could compete against steam in first cost and economy of running.

So far as reliability and ease of control is concerned the electric winder has now made good its case. The question of first cost and economical running is, however, generally in favour of steam winders.

The wider application of central supply schemes, and the electrical equipment of groups of mines, must inevitably lead to a more extensive use of electric winding. Many collieries produce large quantities of a low-grade fuel from their coal-cleaning plants which is almost unmarketable, and has to be used for steam-raising purposes at the colliery, and in many cases this is a factor in favour of steam entirely outside the relative merits of the two systems.

This Paper is concerned with discussing the problem of electric shaft winding. It is necessary to fix the following preliminary details: (1) The quantity of coal to be raised, the cage load, the number of winds per day or per hour, the time per wind and the average speed; (2) the strength, weight and size of the winding rope to be used; (3) the diameter of the drum and sheaves to be used; (4) the inertia, acceleration and retardation of the moving masses; (5) the determination of the speed, torque and power diagrams from the foregoing data; and (6) the determination of the horse-power of the motor from the torque diagram.

The method of dealing with the problem will be best illustrated by selecting an example. It is desired to raise an output of 640 tons of coal in eight hours from a shaft 150 fathoms deep—*e.g.*, the hutches hold 10 cwt. of coal and weigh 4 cwt. when empty. The problem is to find the cage load and horse-power of the motor for a maximum speed of, say, 40 ft. per second in the shaft.

Cycle of Operations.—The output of coal per hour is 640/8=80 tons, and as each hutch holds half a ton of coal it requires 80/0·5 =160 hutches per hour to deal with the output.

As two hutches must be drawn per wind, this gives 80 winds per hour, and the time per wind is

$$60 \times 60/80 = 45 \text{ seconds.}$$

Allowing 15 seconds for changing hutches at top and bottom, these operations being simultaneous, the running time will be the total time per wind minus time for changing—

$$45 - 15 = 30 \text{ seconds.}$$

With uniform acceleration and retardation, the average speed from rest to maximum is

$$0 + 40/2 = 20 \text{ ft. per second,}$$

and from maximum to rest

$$40 + 0/2 = 20 \text{ ft. per second,}$$

the same as for acceleration. If the period of acceleration is fixed [illegible] and the period of retardation at five seconds, we get the following: Acceleration, 10 seconds, distance load moves 200 ft.; [illegible] distance load moves 100 ft. The sum of [illegible] travelled by the load, leaving 900 [illegible] 300 [illegible] the full speed period. Since the load [illegible] 40 ft. per second during this period, the time taken to [illegible]

[illegible]

[illegible] follow: Acceleration, [illegible] 15 seconds; retardation, five seconds; [illegible] per wind, [illegible] seconds.

[illegible] the strength, weight and [illegible]

[illegible]	cwt.	lb.
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	10	1,120
[illegible]	14	1,568
[illegible]	[illegible]	616

* Paper read [illegible] Mining Institute of [illegible]

A preliminary calculation shows the weight of the rope to be about 10 lb. per fathom, or roughly 14 cwt.

Since the load is uniformly accelerated from rest to a speed of 40 ft. per second in 10 seconds, the rate of acceleration is

$$\frac{\text{Velocity}}{\text{Time}} = \frac{40}{10} = 4 \text{ ft. per second per second.}$$

The unbalanced load which has to be accelerated consists of the weight of coal + friction + weight of rope, or

$$2{,}240 + 1{,}120 + 1{,}568 = 4{,}928 \text{ lb.}$$

Now the force F in poundals required to produce an acceleration α in a given mass, M, is equal to the mass multiplied by the acceleration.

Thus

$$F = M\alpha$$
$$= 4{,}928 \times 4$$
$$= 19{,}712 \text{ poundals.}$$

Or

$$F = \frac{19{,}712}{32} = 616 \text{ lb. weight.}$$

Rope.—The total load on the rope, exclusive of its own weight, is

$$2{,}800 + 2{,}240 + 896 + 1{,}120 + 616 = 7{,}672 \text{ lb.}$$

Assuming the rope to be constructed of six strands of 19 wires each and the breaking stress of the steel to be 120 tons per square inch, the size and weight of the rope is given by the following:—

$$W = \frac{G}{\frac{L \times S}{100 \times F} - D}$$

where W = weight of rope in lbs. per fathom.

G = total weight at end of rope in lbs.

L = length of rope in fathoms which is just self-supporting when constructed from steel of a tensile strength of 100 tons per square inch; for the type of rope considered this length is 7,350 fathoms.

S = ultimate strength of the steel used in tons per square inch.

F = factor of safety; 10 for a winding rope.

D = depth of the shaft in fathoms.

Substituting the numerical values in the above formula,

$$W = \frac{7{,}672}{\frac{7{,}350 \times 120}{100 \times 10} - 150} = \frac{7{,}672}{732} = 10{\cdot}4.$$

(Circumference of rope in inches)^2 = weight in pounds per fathom.

Therefore circumference $= \sqrt{10{\cdot}4} = 3{\cdot}2$ in.

The rope diameter is

$$3{\cdot}2/3{\cdot}14 = 1 \text{ in. approximately.}$$

The diameter of the drum may be taken as 120 times the diameter of the rope, or say 120 in. = 10 ft. The pulleys for the headgear should also be of the same diameter.

In an actual case the drawings for the drum would be made, and the weight and radius of gyration taken out from the drawings. For our purpose we will take the ratio between the static load (load + friction) and the mass of the drum to be 1·25 to 1·0, a ratio which is fairly common in practice.

Drum.—Having found the weight and the radius of gyration of the drum and the other rotating parts, such as headgear pulleys and motor armature, they are all reduced to the drum diameter by applying the formula

$$W = K^2 G / R^2 = x,$$

where W = weight in lbs.

K = radius of gyration of rotating part.

R = radius of drum.

G = gravity.

x = equivalent weight at radius of gyration of arm.

The unbalanced load consists of the coal, 2,240 lb., and the rope 1,568 lb., giving a total of 3,808 lb. Adding 15 per cent. for friction, we get roughly 2 tons, or 4,480 lb.

The drum weight is 2 [illegible] 1·25 = 2·5 tons, and the radius of gyration, say, 4 ft.

Reduced to drum radius, this is

[illegible] 112 lb.,

which at 1 ft. per second per second acceleration requires an accelerating force of 118 lbs.

Two headgear pulleys of, say, 10 cwts. each, and radius of gyration 4 ft., when reduced to drum diameter gives

$$(1{,}120+1{,}120)\times 4\times 4/32\times 5\times 5=45\ \text{lbs.},$$

which at 4 ft. per second per second requires an accelerating force of 180 lbs.

Taking armature weight at 3 tons, and radius of gyration as 1 ft., we get

$$6{,}720\ [illegible]\ 1/32\ [illegible]\ 5\ [illegible]\ 5=8\cdot 4\ \text{lbs.},$$

which at 4 ft. per second per second acceleration requires an accelerating force of 33·6 lbs.

We have already worked out the accelerating force for the unbalanced static load in the shaft as 616 lbs., so that the total force for acceleration is

$$448+180+33\cdot 6+616=1{,}277\cdot 6,\ \text{say}\ 1{,}278\ \text{lbs.}$$

We can now proceed to draw the speed, torque and power diagrams from these data. These are best drawn on one sheet, and on a base corresponding to the time taken to complete one run from the pit bottom to the pit top.

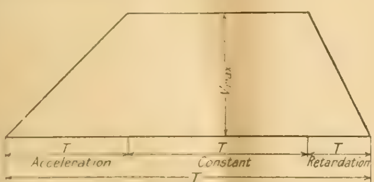


Fig 1.–Speed Diagram.

Speed Diagram.—(Fig. 1.) The maximum height of the diagram represents the maximum velocity, $V_{max.}$, and the average height represents the mean velocity, V_{mean}. But the area of the diagram is obtained by multiplying the length of the base T by the average height, hence the area of the diagram gives the depth of the shaft.

Let A = area of diagram.
T_a = time of acceleration in seconds.
T_{r} = time of retardation in seconds.
T_{f} = time of full speed in seconds.
T = total running time in seconds.

Then $A = V_{max}$ [illegible]

[illegible]

and [illegible]

Torque Diagram.—(Fig. 2.) This diagram is plotted to the same base as the speed diagram and derived therefrom. It should

[illegible]

[illegible]

Substituting in the torque formula [illegible] already given in the table of weights, and that calculated as the total force due to acceleration, we get:—

Torque (acceleration)$=(3{,}808-1{,}120+1{,}278)\ 5=31{,}030$ pd.-ft.
Torque (constant)$=(3{,}462-1{,}120)\ 5=22{,}910$ pd.-ft.
Torque (retardation)$=(2{,}413-1{,}120-1{,}278)\ 5=11{,}275$ pd.-ft.

The weight of the rope has been taken as diminishing at each step, instead of uniformly through the run: this simplifies matters and makes no material difference in the ultimate result. With a heavier rope and a deeper shaft it would be advisable to consider the uniform decrease of rope weight on the load side and the corresponding increase on the empty side.

Power Diagram.—[illegible] and power is the amount of work [illegible] obvious that the power diagram (Fig. 3) can be plotted on the same time base as the speed and torque diagrams, thus

Power (acceleration) [illegible]
Power (constant)$=(P_l-P_r)\ V$
Power (retardation) [illegible]

where V is the velocity in feet per second.

Substituting values we get

Power (acceleration) [illegible] 124,120 [illegible]
Power (constant)$=(3{,}462-1{,}120)\ 40=183{,}280$ ft.-lbs.
Power (retardation)$=(2{,}413-1{,}120-1{,}278)\ 20=45{,}100$ ft.-lbs.
and 124,120 ft.-lbs. for 10 seconds = 1 241,200 ft.-lb.-seconds.
183,280 ft.-lbs. for 15 seconds = 2,749,200 ft.-lb.-seconds.
45,100 ft.-lbs. for 5 seconds = 225,500 ft.-lb.-seconds.

The sum of these numbers, 4,215,900, divided by the time per run, 30 seconds, and by 550, the number of foot-lbs. per second in one horse-power, gives

$$4{,}215{,}900/30\times 550=256\ \text{horse-power}.$$

This is the average horse-power expended during the run.

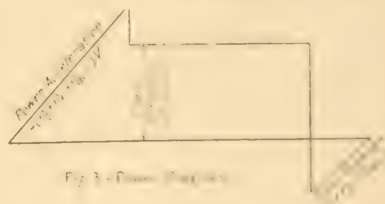


Fig. 3.–Power Diagram.

[illegible]

means of drawing the men should one motor fail. There is, however, no more need for such a provision than there is for a second steam winder as a stand-by; besides, facilities for drawing men from the other shaft must be provided to satisfy the Mines Act.

At most collieries it is customary to raise and lower the men at a reduced speed; also rope inspection and shaft examination or repair necessitate the speed being reduced to a mere crawl. To meet these conditions the winding motor must be fitted with a controlling device of ample range and suitable capacity.

EQUALISING THE LOAD.

With such a winder the motor might be fed direct from the mains of a power company supplying a fair output, or it might be worked in conjunction with an equalising apparatus, whereby the peak load would be levelled, and the maximum demand on the supply mains diminished.

There are several such systems, but the Ilgner is perhaps the best known. In this a motor-generator fitted with a heavy flywheel is installed. The motor side is fed from the general source of supply. The dynamo side is so constructed that the voltage can be varied between zero and the full amount allowed for in the design. This dynamo feeds the winding motor, which is necessarily of the direct-current type. During the acceleration period the winder makes a large demand on the motor-generator, and thus tends to increase the current taken by the motor side. The current taken from the mains is prevented from rising by means of a regulating device, and the dynamo side supplies the demand made upon it by drawing upon the stored-up energy of the rotating flywheel. This borrowed energy, together with that supplied by the motor side of the motor-generator, meets the demand of the winding motor at any moment. In the event of the load upon the winding motor being negative or zero the whole output of the motor side of the motor-generator is stored in the flywheel the current from the mains being prevented from falling off, as it has a tendency to do, by means of a suitable regulating device.

In the case under discussion the power diagram shows an average of 256 H.P. during the wind, and an expenditure of 4,215,900 ft. lb. during the 30 seconds occupied by the run. If this be equalised over the 45 seconds of a complete cycle—namely, running and banking periods—we get

$$4{,}215{,}900/45 \times 550 = 171 \text{ H.P.}$$

This 171 is the brake-horse-power that must be constantly furnished by the motor side of the motor-generator; therefore

$$256 - 171 = 85 \text{ H.P.}$$

has to be borrowed from and paid back to the flywheel during each wind.

If the motor-generator be fitted with a flywheel of 10 tons weight, revolving at 750 revs. per min., with a radius of gyration of 3 ft., then the kinetic energy K_1 stored in the wheel is

$$MV_1^2/2G \text{ ft.-lb.},$$

where G=gravity

M=mass in lbs.

V_1=velocity of a point at the mean radius in feet per second.

If now a demand for $85 \times 33{,}000$ ft.-lbs. has to be supplied from the stored-up energy in the revolving wheel, the speed will fall to V_2 when the demand is completed, and the kinetic energy K_2 remaining in the wheel will be

$$MV_2^2/2G \text{ ft.-lbs.}$$

The flywheel, therefore, loses $K_1 - K_2$ ft.-lbs.

or

$$\frac{MV_1^2}{2G} - \frac{MV_2^2}{2G} = \frac{M}{2G}(V_1^2 - V_2^2).$$

Therefore

$$V_1^2 - V_2^2 = \frac{2G}{M}W,$$

where W is the ft.-lbs. of energy given up.

The revolutions per second equal

$$750/60 = 12{\cdot}5;$$

and with a mean radius of 3 ft. we get

$$V_1 = 2 \times 3 \times 3{\cdot}14 \times 12{\cdot}5 = 236 \text{ ft. per second.}$$

$$\therefore \quad V_1^2 = 236 \times 236 = 55{,}696.$$

$$V_1^2 - V_2^2 = \frac{2G}{M}W = \frac{2 \times 32{\cdot}2}{2{,}240 \times 10} \times 85 \times 33{,}000 = 8{,}064.$$

Substituting the value of V_1, we have

$$55{,}696 - V_2^2 = 8{,}064.$$

Therefore

$$V_2 = \sqrt{55{,}696 - 8{,}064} = \sqrt{47{,}632} = 214 \text{ ft. per second.}$$

and $236 - 214 = 22$ ft. per second, or a speed fluctuation of about 10 per cent.

The chief advantages of a regenerative system such as that described lie in the equalised load thrown on the mains, and the ability to continue winding for several runs using the stored-up energy in the flywheel should the main current fail.

NOTES ON THE DESIGN OF ELECTROMAGNETIC MACHINES.*

PART II.

DESIGN OF A SLOW-SPEED ALTERNATING-CURRENT GENERATOR.

BY STANLEY PARKER SMITH, D.SC.

(*Continued from page* 12.)

Summary.—In Part I of the article the author deals with some of the main principles underlying the design of alternating-current generators. In Part II these principles are applied to the design of a low-speed, three-phase alternator, giving 750 kw. at 2,200 volts, when running at a speed of 250 revs. per min. In Part III a three-phase turbo-alternator is designed to give 2,000 kw. at 3,000 revs. per min. at a line pressure of 500 volts, and the mechanical stresses in the rotor are discussed.

(c) *Stator Slot.*—With the good cooling properties of the [illegible] winding and the good fanning action to be expected in this machine, the stator copper can be worked at a density of about 4 amperes per mm.², so that the cross section of copper needed will be about 246/4 = 60 mm.² To keep down the [illegible] in the teeth the strip should be made deep, whilst to keep down eddy currents due to the armature flux the strip should be shallow. A strip 10 mm. in depth makes a suitable proportion, which gives a width of 6 mm. For this we can use either a single strip 10 × 6 mm., or if facilities for bending [illegible] copper are not available two strips 10 × 3 mm. [illegible] can be used.

To insulate the [illegible] we can first tape each coil separately and then the three coils belonging to the same slot can be taped together with a [illegible] of [illegible] or mica paper [illegible] over the slot part. Then the three coils are inserted together in the slot as described, the ends being left straight until the [illegible] in position. [illegible] the slots are [illegible] the coils [illegible] must be [illegible] from one side of the machine.

For the slot dimensions we shall have then (see drawing, Fig. 13):

Slot-width:

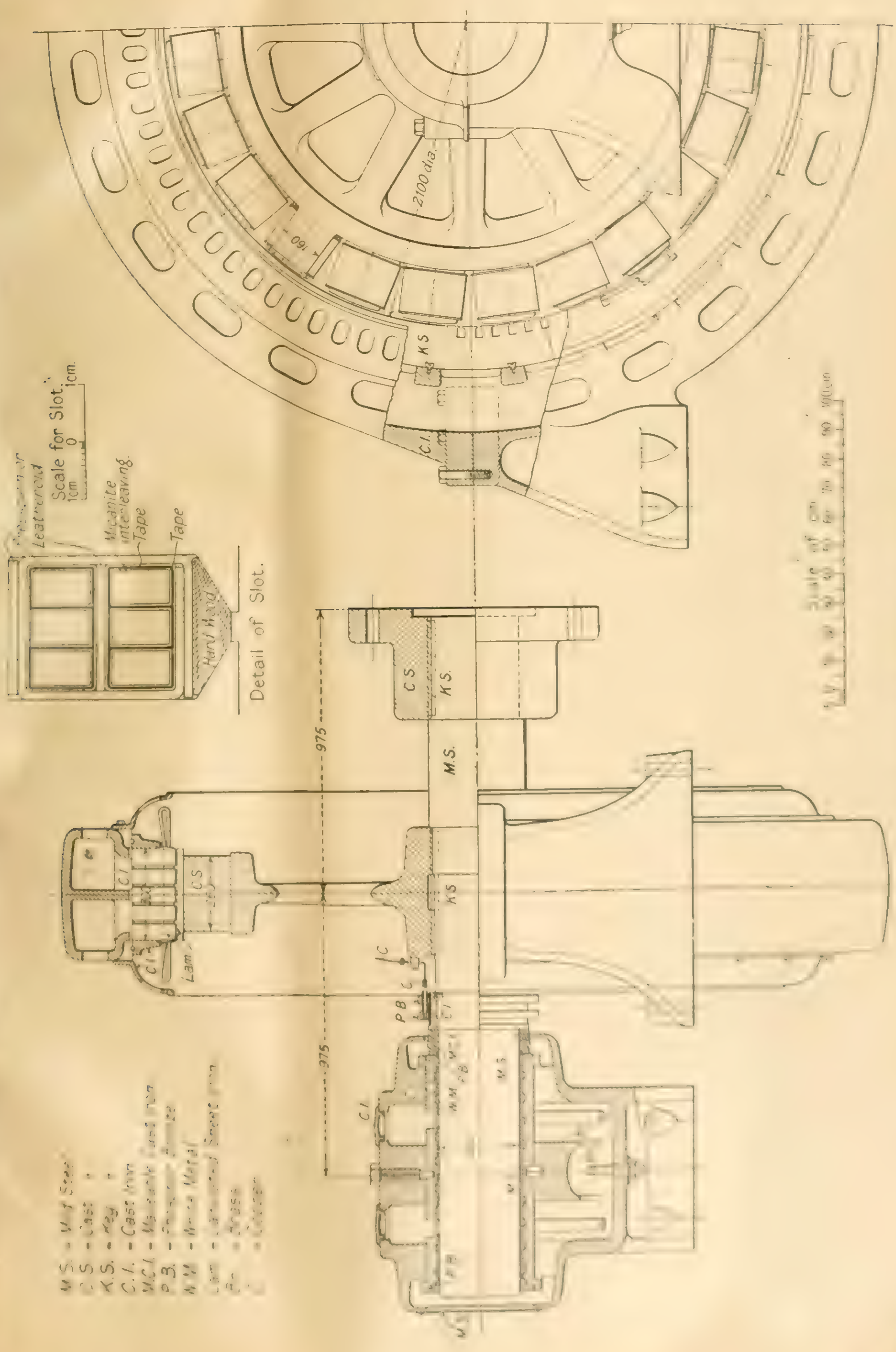
Slot insulation	$2 \times 1{\cdot}25$	2·5	mm.
Coil taping	$2 \times 0{\cdot}35$	0·7	„
Interleaved insulation	$4 \times 0{\cdot}125$	0·5	„
Conductor taping	$3(2 \times 0{\cdot}35)$	2·1	„
Conductors	3×6	18·0	„
Clearance		1·2	„
Total		25·0	„

Slot-depth:

Slot insulation	$3 \times 1{\cdot}25$	3·75	mm.
Coil taping	$2(2 \times 0{\cdot}35)$	1·4	„
Interleaved insulation	$4 \times 0{\cdot}125$	0·5	„
Conductor taping	$2(2 \times 0{\cdot}35)$	1·4	„
Conductors	2×10	20·0	„
Insulation at bottom of slot		1·0	„
Insulation between layers		1·0	„
Clearance		3·95	„
Wood or fibre wedge		6·0	„
Slot lip		1·0	„
Total		40·0	„

Thus the slot will be 25 mm. wide × 40 mm. deep.

* [illegible] Continuous-current Machines [illegible] appeared in THE ELECTRICIAN of [illegible], 1916, Vol. LXXVII., p. 28[illegible].


Scale for Slot.
1cm 0 1cm
Detail of Slot.
Hard Wood
Tape
Micanite interleaving
2100 dia.
160
975
M.S.
K.S.
C.S.
C.I.
Lam.
P.B.

The slot-opening is reduced to 5 mm. both to reduce the reluctance of the air-gap and the loss due to the main flux swinging and pulsating.

For the slot insulation, presspahn interleaved with mica can be used. Though the slack in the depth appears ample it must be remembered that the coils have to be pushed in from the side, and so more room is needed than when coils are dropped in open slots. The actual clearance in the depth, however, does not matter very much so long as it is enough, because the wedge is always made so that when driven in it holds the coils tight. For this purpose wood wedges are very good.

From the calculation of the magnetic circuit it will be seen that the flux-density in the teeth is not too high with this slot.

(*d*) *Weight and Resistance of Stator Winding.*—From the drawing we find that the length of the overhang is 46 cm. Adding this to the core-length, the length of a conductor is $46+32=78$ cm. There are $2\times117=234$ conductors per phase, so that the length of copper per phase $L=234\times78=18{,}300$ cm. $=183$ m.

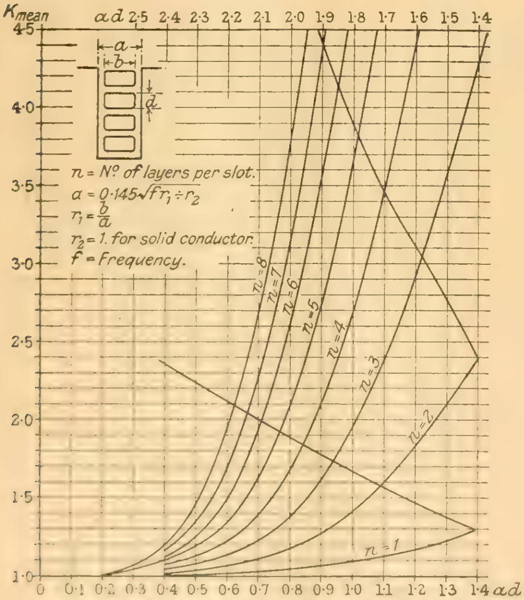


Fig. 14.—Increase in Loss due to Eddy Currents in Slot Copper.
(Mean value of Field's curves.)

The net *weight* of stator copper is then:

$$W = 8{\cdot}9\,AL\,10^{-3} = 26{\cdot}7 \times 0{\cdot}6 \times 18{,}300 \times 10^{-3} = 293 \text{ kg.}$$

For the *resistance* we have not only the ohmic loss proper, but also the increase due to eddy currents. The latter is generally calculated by aid of Field's curves (see "Proc. A.I.E.E.," Vol. 24, p. 761). Instead of finding the extra loss in each layer and taking the mean, we can re-draw Field's curves to represent the mean increase in loss with different numbers of layers in the slot as shown in Fig. 14. These curves are in a handy form for use in the Design Office.

Applying the curves to the present case we have:

$$r_1 = \frac{1{\cdot}8}{2{\cdot}5}, \quad r_2 = 1 \text{ and } f = 50,$$

$$\text{so that } a = 0{\cdot}145\sqrt{f\frac{r_1}{r_2}} = 0{\cdot}145\sqrt{50\frac{1{\cdot}8}{2{\cdot}5}} = 0{\cdot}87.$$

The depth $d = 1{\cdot}0$ cm., hence $ad = 0{\cdot}87$. From the curve for $n=2$ in Fig. 14 we see that the increase in loss in the copper in the core is 24 per cent. This is equivalent to an increase in loss in the whole winding of $\frac{32}{78}\times24=10$ per cent.

The *ohmic* resistance per phase is:

$$R = 0{\cdot}0173\frac{L}{A} = 0{\cdot}0173\frac{183}{60} = 0{\cdot}053 \text{ ohm at } 15^{\circ}\text{C.},$$

so that the *effective* resistance per phase is:

$$R = 1{\cdot}1 \times 0{\cdot}053 = 0{\cdot}058 \text{ ohm at } 15^{\circ}\text{C.},$$
$$= 0{\cdot}058(1+0{\cdot}004\times55) = 0{\cdot}071 \text{ ohm at } 70^{\circ}\text{C.}$$

This allows for a temperature rise of 45°C. above an engine-room temperature of 25°C.

(*e*) *Resistance Drop and Loss in Stator Winding.*—The resistance drop per phase at full load is $0{\cdot}071\times246=17{\cdot}5$ volts $=1{\cdot}38$ per cent. of the phase pressure.

The stator copper loss is then:

$$3\times17{\cdot}5\times246\times10^{-3}=13 \text{ kw.}$$

(*f*) *Reactive Drop in Stator Winding.*—In an alternator it is not necessary to know the inductance, or the leakage flux, of the stator winding with the same accuracy as in an induction motor, because its effects are less important under normal working conditions. We shall, therefore, only estimate the leakage flux in the approximate manner described in section 5, Part I., by applying equations 9 and 10.

For the leakage flux associated with the slots we have:

$$\Phi_s = 3{\cdot}55 I q L_s \lambda = 3{\cdot}55\times246\times6\times28\times1{\cdot}23 = 0{\cdot}18\times10^6,$$

$$\text{where } \lambda = \frac{22}{3\times25}+\frac{6}{25}+\frac{2\times6}{25+5}+\frac{1}{5}+\frac{0{\cdot}5}{5{\cdot}64} = 1{\cdot}23.$$

For the leakage flux associated with the overhang:

$$\Phi_0 = k I q u L_0 = 1{\cdot}8\times246\times1{\cdot}625\times6\times(46+4) = 0{\cdot}22\times10^6,$$

where L_0 is taken to include the ventilation ducts.

Thus the leakage flux associated with a magnetic circuit is:

$\Phi_s+\Phi_0 = 0{\cdot}4\times10^6 = 8$ per cent. of the normal flux per pole. (Normal flux per pole $\Phi = 4{\cdot}96\times10^6$, *see* sect. 3 (*a*)).

The *true* reactance voltage per phase is then $100\Phi_0/\Phi = 4{\cdot}4$ per cent. (56 volts), and the *fictitious* reactance voltage per phase is $100\Phi_s/\Phi = 3{\cdot}6$ per cent. (46 volts).

(*g*) *Cooling of Stator.*—In a machine of this kind the overhang of the stator winding will not only get rid of its own heat, but probably of a fair amount of heat generated in the slot copper also. Assuming, however, that the overhang only gets rid of the heat generated in it, the loss to be dissipated from the stator surfaces will be the iron loss plus the embedded copper loss. The iron loss is 21 kw.—*see* sect. 3 (*f*)—and the slot copper loss is $1{\cdot}24\,(0{\cdot}053\times32/78)\,(1+0{\cdot}004\times55)\,246^2\times3 = 6$ kw., making together 27 kw.

The cooling surfaces are the external surface, the gap surface and the surface of the ducts.

(i.) For the external cooling surface of the stator we have the outside of the core and the two end plates. From the drawing, Fig. 13, we estimate this surface to be

$$\pi240\times28+2\pi12\times228=21{,}000+17{,}000=38{,}000 \text{ cm.}^2$$

Allowing 0·15 watt per cm.², the outside surfaces dissipate $0{\cdot}15\times38{,}000\times10^{-3}=5{\cdot}7$ kw., leaving $27-5{\cdot}7=21{\cdot}3$ kw. to be got rid of at the gap and duct surfaces.

(ii.) For the cooling effect of the gap and duct surfaces, if we assume the difference of temperature between iron and air is fairly constant, we can combine the formulæ given by Kapp and Miles Walker as follows:

Mean temperature difference between iron and air

$$t = \frac{\text{loss in watts}}{\frac{1+0{\cdot}1v}{k_1}A_1 + k_2 v_d A_2} \ ^{\circ}\text{C.},$$

where v = peripheral speed = 27·5 m. per sec.,
v_d = velocity of air in ducts = 3 m. per sec (estimated $=0{\cdot}1v$),
k_1 = coefficient = 333,
k_2 = coefficient = 0·0012 (a mean value),
A_1 = gap surface = $\pi210\times32 = 21{,}000$ cm.²,
A_2 = surface of ducts = $8\pi11\times229+8\times117\times3{\cdot}3\times4 = 76{,}000$ cm.²

Inserting these values we get

$$t = \frac{21{,}300}{237+273} = 42°C.$$

Thus it is not likely that the temperature rise at any accessible part will exceed 50 C.

The coefficients used are chiefly taken from Miles Walker, but in practice a designer should deduce these from test results.

3. THE MAGNETIC CIRCUIT.

(*a*) *Flux.*—The flux per pole is found from the E.M.F. equation $E_p = kfT\Phi 10^{-8}$ volts, where the E.M.F.-coefficient k can be taken as for a rectangular flux distribution. Thus for $b/Y=0{\cdot}7$, $k=4{\cdot}37$.*

Then
$$\Phi = \frac{E_p 10^8}{kfT} = \frac{E_p 10^8}{4{\cdot}37 \times 50 \times 117} = \frac{E_p}{256} 10^6.$$

The flux on no-load at normal pressure will then be:

$$\Phi = \frac{1270}{256} 10^6 = 4{\cdot}96 \times 10^6.$$

(*b*) *Dimensions of the Magnetic Circuit.*—We can now settle the dimensions of the different parts of the magnetic circuit.

(i.) *Stator Core.*—At a frequency of 50 cycles the stator core can be worked at a density of 8-10,000 lines per cm.². If we make the outside diameter of the stator 240 cm. we get a core-depth:

$$h = \frac{240 - (210 + 2 \times 4)}{2} = 11 \text{ cm.},$$

so that the iron area will be:

$$a_s = hL_i = 11 \times 25{\cdot}2 = 277 \text{ cm.}^2,$$

giving a flux-density in the core

$$B_s = \frac{\Phi_0}{2a_s} = \frac{4{\cdot}96 \times 10^6}{2 \times 277} = 9{,}000,$$

which is quite satisfactory.

(ii.) *Teeth.*—In salient-pole machines nearly all the flux goes through the teeth directly under the pole-shoes.

The slot-pitch at the periphery $y_s = \pi D/S = 660/117 = 5{\cdot}64$ cm., hence the number of teeth per pole: $b/y_s = 19{\cdot}5/5{\cdot}64 = 3{\cdot}37$. We shall round this off to 3·5 to allow something for fringing.

Then we have:

Slot pitch at maximum tooth section: $\pi(210+2\times4)/117 = 5{\cdot}85$ cm.
" " minimum " " $\pi(210+2\times1)/117 = 5{\cdot}68$ "
hence, tooth-width at maximum tooth section: $5{\cdot}85 - 2{\cdot}5 = 3{\cdot}35$ "
and " " minimum " " $5{\cdot}68 - 2{\cdot}5 = 3{\cdot}18$ "
Thus, maximum section of teeth: $3{\cdot}5 \times 25{\cdot}2 \times 3{\cdot}35 = 295$ cm.²
and minimum section of teeth: $3{\cdot}5 \times 25{\cdot}2 \times 3{\cdot}18 = 280$ cm.²,

so that the minimum flux density in the teeth: $Bt_{min} = \dfrac{4{\cdot}96 \times 10^6}{295} = 16{,}800$

and maximum " " " $Bt_{max} = \dfrac{4{\cdot}96 \times 10^6}{280} = 17{,}700.$

These densities are permissible.

(iii.) *Air-gap.*—Since there are no stringent regulation guarantees to be met it is only necessary to make the length of the air-gap sufficient to meet mechanical requirements. We shall make the gap 5 mm. at the centre of the shoe and [illegible] the tips to round off the corners of the B curve. The effective area of the air-gap is found in precisely the same way as for continuous-current machines, where the use of Carter's curve was fully explained.

The slot opening has been fixed at 5 mm., so that

$$\frac{\text{slot opening}}{\text{air-gap}} = \frac{s_0}{l_g} = \frac{5}{5} = 1,$$

whence from Carter's curve $y = 0{\cdot}16$,

so that the effective arc $b_e = b - s_0 \frac{b}{y_s} y = 18{\cdot}7$ cm.

* See "The Shape of the Pressure Wave in Electrical Machinery." By Smith and Boulding. Proc. I.E.E., Vol. LIII., p. 225.

Similarly with 10 mm. ventilation ducts we get:

$$\frac{\text{duct opening}}{\text{air-gap}} = \frac{d_v}{l_g} = \frac{10}{5} = 2,$$

for which Carter's coefficient $y'' = 0{\cdot}28$;

so that the effective length $L_g = L - n_v d_v y'' = 30{\cdot}9$ cm.

Hence the effective area of the air-gap will be

$$b_e L_g = 18{\cdot}7 \times 30{\cdot}9 = 578 \text{ cm.}^2$$

This is about 95 per cent. of the area of the shoe [illegible], and is quite a common figure with semi-closed slots, whereas with open slots this ratio may be as low as 85 per cent.; thus showing what a large saving in field copper is obtainable with semi-closed slots, especially when the air-gap is small.

(iv.) *Poles and Yoke.*—There are many forms of pole construction that might be adopted, and the choice depends largely on standard practice. Space restrictions make the use of a round pole seldom possible in alternators not tied down to stringent regulation guarantees, if the materials are to be employed to the best advantage. Consequently some form of rectangular or oval pole is essential, the particular arrangement depending mainly on how the pole and exciting coil are to be secured.

Since the shoe has usually to be laminated some makers stamp the pole and shoe in one piece, making the thickness of the shoe sufficient to carry the weight of the bobbin. This leads to a laminated rectangular pole, which must be secured to the yoke by means of screws. If space permits the head of the screw is inside the yoke, otherwise it must be countersunk in the shoe; but in any case it is usually needful to have a steel piece through the pole to screw into or press on as the case may be, because the laminations alone are insufficient to withstand the centrifugal force of the pole and coil. For laminated poles No. 16 S.W.G. [illegible] may be used, but it must be remembered that the [illegible] greatly reduces the [illegible] of the pole [illegible], thereby increasing the [illegible] considerably.

Solid poles can be round, oval or rectangular, as desired, and can be either bolted to the yoke or cast with it. [illegible]

[illegible]

[illegible] struction for the [illegible]

[illegible]

shall use [illegible]

After [illegible]

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THE NEED FOR TECHNICAL LIBRARIES.

We have frequently urged the importance of the technical library, and therefore it is with much satisfaction that we read last week the account of Dr. ADDISON's address to the Library Association. Although the value of the technical library has been realised to a limited extent for many years, the importance of such institutions has not been fully recognised by those engaged in industry. Here and there such libraries exist of more than usual value, notably in London, in certain public institutions, or as the property of learned societies, and also in some of our larger provincial towns. But this is not enough. Under present conditions, to the mass of those who are engaged in our industries a first-class technical library is not easily available. In our opinion, every town which is sufficiently large to be identified seriously with a particular industry should possess a library dealing adequately with the literature of that industry.

Dr. ADDISON was right in remarking that during the war this country has been handicapped to a tragical degree by the absence of scientific and industrial information of a serviceable kind. It is the function of the technical library to render information of this kind conveniently accessible.

Doubtless there are those among us who still set little value upon published information. While it is quite true that such information must necessarily lag behind the best practice, it is equally true that the publication of information of this kind is of the greatest possible value. A maker of, say, a standard line of motors may consider that current literature can teach him very little. This may be so up to a point, but it is not true if advances are being made in his particular line of business by others as well as by himself. It is also true that any firm which is advancing rapidly will be in advance of published information in their branch of work. For example, those who were engaged in working the Birkeland-Eyde process for the fixation of nitrogen some 10 years ago were then very much in advance of published information on this subject. It does not follow, however, that others wishing to branch out into this line of activity found such information useless. Our text books, and more particularly original communications of one kind and another, necessarily lay the foundations of every new advance.

There is, of course, the question of meeting the cost of maintaining technical libraries. We think the time has come when this cost should be met by the local rates. Every town benefits by the prosperity of the industry with which it is connected, and therefore, it should support any steps leading to increased efficiency of such industry. At the present time authors are compelled to give copies of their books to certain privileged libraries, and this course might possibly be adopted to a greater extent. We hope, however, that technical libraries will be so numerous in the future that this method of obtaining books would prove something of a hardship upon authors and publishers alike. Some of the cost would no doubt be met by contributions from the industries concerned, but we do not believe in adopting a basis of charity, and we feel that the upkeep should be one for municipal funds.

The technical library is essentially a "reconstruction" matter, being connected with the welfare of our industries, and we are therefore glad that it is engaging the attention of Dr. ADDISON, the recently appointed Minister of Reconstruction. Among the few economies that have been made during the war has been the curtailment of hours during which museums and libraries are open to the public, and the total closing of some of our institutions. The result has been the saving of a paltry sum compared with our present expenditure, and it seems to us that this saving has been much outweighed by the loss of these facilities. The Patent Office Library in London is a case in point. Before the war this library was open until 10 o'clock at night, but now it is closed at five o'clock. Apart from the crank inventors who frequent this library, there are any number of technical men who cannot conveniently consult the library between the hours of 10 a.m. and 5 p.m., but who would willingly do so at a later hour. This is particularly the case at the present time, when work is carried on under difficult conditions, and we do not doubt that this curtailment of hours has been severely felt by many to whom such a library is of great importance. All of which shows that the utility of such an institution is not realised by the "powers that be." After the war we trust that the recognition of the value of the technical library will be widespread, and that no industrial centre will be without such an institution adequate to its needs.

REVIEW.

Primary Batteries: Their Theory, Construction and Use. By W. R. COOPER, M.A., B.Sc. (London: Benn Brothers, Ltd.) Pp. x.+457. 12s. 6d. net. "The Electrician" Series.

This book, originally published in 1901, has now been brought up to date in a new edition, and much enlarged with the addition of some new chapters which materially enhance the value of the work.

The first five chapters are devoted mainly to the purely theoretical side of the subject. The theory is discussed very clearly, and copious references are given to all the experimental work dealing with the matter, which has been published from time to time. Apart from the electron theory, there has, of course, been very little published work of this nature since the issue of the first edition. This section of the book should, however, appeal not only to the makers or users of Primary Batteries, but to those who are interested in the larger question of electrolytic corrosion.

Chapters 8 and 9 contain a full description of the Wet Cells and their electrolytes. Numerous curves are given showing the behaviour of the different types of cells and illustrating their special characteristics.

A most interesting addition to this portion of the book is a *résumé* of the work of J. G. Lucas and M. Solomon, on the effect of the physical quality of the Manganese Peroxide used in the porous pot of Leclanché cells. Most, if not all, of the original curves in Lucas' paper are given illustrating the enormous increase in the capacity of the porous pot when the manganese peroxide is ground very fine instead of, as in the older types of pot, being left in a granular condition. Solomon's work discusses also the size and shape of the grains, mainly from the point of view of the manufacturer, and he expresses a preference for grains of the size of rice, but this opinion has been modified towards a smaller size as the result of further advance. The finer grains give a very much higher capacity when a pot is carefully made, and, while there is still some doubt as to the best size of grain which can be used under commercial manufacturing conditions, the improvements already made, due to the investigation of the size of the granules represent a very important advance.

Mention is also made of the advantage of the sack form of element with finely ground peroxide rammed in very tight and of the mercury zinc amalgam, generally known as the

"Non-Incrusting Zincs," which are a distinct improvement as regards efficiency on the old type of zinc rod, amalgamated only on the surface. The great improvement in the quality of the ordinary Leclanché cell as manufactured in this country is not, perhaps, fully appreciated, and the author is to be congratulated on having brought together all the information in a very clear form.

Dry Cells, their manufacture and testing, are described in Chapter 10. This section includes the form of Leclanché cell, in which all the constituent parts are fixed in the box together with the exciting salts in the correct proportion, requiring only the addition of water to complete the cell. Several new types of dry cell are described of both British and American manufacture. One omission, however, is the cell made by Messrs. Delafon, of Paris, which has been largely used in this country.

Chapter 7 and the latter half of chapter 10 deal with methods of testing both wet and dry cells, giving a description of the apparatus used and the data which is required. The vexed question of the most suitable test for the comparison of dry cells is dealt with at length, and results obtained by other investigators, and in particular a standard method recommended by the American Electro-chemical Society are given.

While pointing out the differences that can be obtained with the various methods of test, the author leans to the continuous test on a fixed resistance as being the simplest to carry out. This, from a testing point of view, is undoubtedly the most satisfactory form of test, but, unfortunately, the comparison of two different makes of dry cells by this method is likely to give results very different from those obtained if the cells were working under normal conditions. The continuous test will, no doubt, provide a reasonable basis of comparison between cells of the same type made from time to time under exactly the same conditions of manufacture, but its use [illegible] two makes of cell, the only satisfactory test is one in which the test conditions approximate nearly to the actual working conditions.

As an example of the continuous method of test, we might take the comparison of wet and dry cells given on page 296. In this case the [illegible] a result which would probably have been somewhat [illegible] if a method of test more nearly in accord with working conditions had been used.

The chapter on Standard Cells is much enlarged, and includes, in addition to full information regarding the Clark cell, an account of all the work carried out during recent years at the American Bureau of Standards and the National Physical Laboratory on the Weston [illegible]. The book, in this respect, provides complete instructions for making up Standard Cells with full particulars as to temperature coefficient, &c.

The volume concludes with a description of the Selenium cell and the Carbon Consuming cells.

Mr. Cooper has dealt with the question of Primary Batteries, both from the theoretical and practical sides, in a comprehensive manner, and the arrangement of illustrations, references and bibliographies is admirable. S. W. MELSOM.

RESULTS OF INTERLINKING SALEM, MALDEN AND REVERE (U.S.A.).*

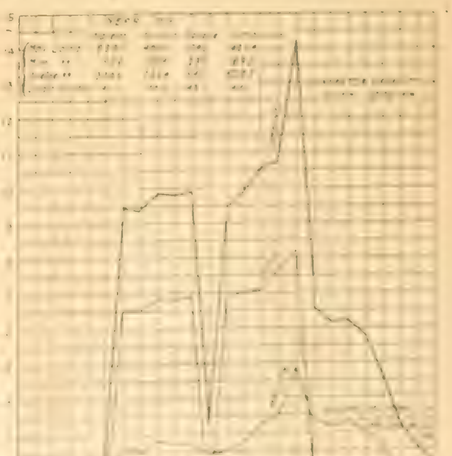
A striking example of the benefits to be derived from co-ordinating generating facilities is afforded by a group of New England companies which have been recently interconnected. This group comprises the Salem Electric Lighting Co., the Malden Electric Co. and the Suburban Gas & Electric Co. of Revere, which are among the most important suburban central stations in the Boston district. These companies are under the management of Charles H. Tenney & Co., of Boston. The transmission tie line was constructed by the Eastern Massachusetts Electric Co., an organisation affiliated with the Tenney interests.

Investigation of the best means of providing additional equipment to meet the growing demand upon these companies showed the engineers of the Tenney organisation that the situation was peculiarly well suited to the construction of a tie line. It was decided to develop the Salem plant as the main source of supply, this station having practically unlimited development possibilities, with ample facilities for coal storage. The plan contemplated the sale of electricity to the Eastern Massachusetts Electric Co., which in turn markets the energy to the Malden and Revere companies, enabling the latter to purchase energy at a price representing a saving over their present production cost, and permitting them to take on increased business without making further capital investment in their plants. Such an investment would otherwise have become necessary at a very early date if the tie line had not been installed.

The establishment of the tie line enables either the Malden or the Revere company to operate its present plant at an economical [illegible] at certain times during the year, and to sell energy to the [illegible] company if the load conditions warrant. The line was placed in service May 1, [illegible] and the results of its service have come close to the [illegible] upon which its construction was [illegible].

Underground cable [illegible] from the Malden plant to a terminal house in Melrose. [illegible] the line is carried on [illegible] [illegible]

(7.2 mm) thick. In Salem 17,000 ft [illegible] installed, and between Malden and Revere [illegible] of cable are in service, [illegible] supplementing a tie line between Malden and Revere which has been in service for several years.



* Abstract of an article in the Electrical World.

Cost of construction and cost of fuel have both risen since the erection of the line was begun, but the economic justification of the line appears from the data published. On Dec. 23, 1915, the peak loads on these stations were 5,200 kw. at Salem, 3,430 kw. at Malden, and 1,080 kw. at Revere. Since the generating capacity available was17,000 kw. at Salem, 3,400 kw. at Malden and 1,400 kw. at Revere, the Salem plant was operating at less than one-third of its rating, the Malden station was slightly overloaded and the Revere plant was about three-quarters loaded. The peak load on the last-mentioned station, however, came at 8 p.m., whereas the peaks on the two other stations occurred at 5 p.m. The Salem plant had the poorest load factor of the three, although it is the most modern station. Typical summer load conditions also show the Salem plant at a disadvantage with respect to Malden, but the Revere station had the poorest load factor of the three.

The typical summer conditions for 1916 are shown in Fig. 1. It will be seen that the use of a tie line permits handling the 1916 winter load on the Salem station alone if need be, whereas if the Malden plant had been forced to depend upon itself its rating would not have been sufficient to meet the demand upon it by about 1,495 kw. Revere in 1916 came close to its rating, with little or no reserve. A chart of the kilowatt-hours produced each month in 1915 by the three stations, and including a totalising curve assuming all the output handled by the Salem plant, is shown in Fig. 2.

The following data and analysis give the basis for establishing a selling price for the energy supplied to and sold by the transmission company, and show the saving realised by each company by inter-connection :—

Production Cost of Salem Company, 1916 Basis.*

	Per Kw.-hr.
Fuel	$0.005000
Fuel handling	0.000095
Water	0.000240
Lubricants	0.000100
Total	$0.005435
Plus 10 per cent. profit	0.000543
Total	$0.005978

This establishes a selling price to the transmission company of $0·006. Annual output of Malden company at switchboard (saleable) = 10,000,000 kw.-hr. Assuming a line and transfer loss of 8 per cent., the transmission company is obliged to purchase for the Malden company 10,800,000 kw.-hr.

The Revere company's output at its switchboard is 3,500,000 kw.-hr. yearly. Assuming a line and transformer loss of 10 per cent., the transmission company must buy for the Revere company 3,850,000 kw.-hr.

	Kw.-hr.
Total energy purchased by transmission company	14,650,000
Total energy sold by transmission company	13,500,000

By purchasing all the above energy from the Salem company at $0·006 per kw.-hr., it would pay the Salem company $67,900 and the latter would make a profit on this of $0·000565 per kw.-hr., or $8,277.25.

Malden Electric Co. Costs, 1915 Basis.

	Per Kw.-hr.
Total production cost of energy at Malden	$0.01050
Estimated* cost of purchased energy	0.00985
Saving per kilowatt-hour	$0.00065

Or $7,200 per year.

The estimated* cost of purchased energy included the following items of station operation at Malden :—

[illegible] and care	$2,000
[illegible]	3,120
[illegible]	1,050
[illegible]	500
[illegible]	500
[illegible]	1,000
Total	$9,180
[illegible] production of 10,800,000 [illegible]	$0.00085
Cost of purchased energy	0.00900
Total [illegible]	$0.00985

[illegible] the selling price of [illegible] to make any [illegible]

* The estimated cost of purchased energy is the amount paid the transmission company plus expense of running distributing station.

At the time of the investigation the Malden company had signed a contract for nearly 1,000 kw. additional load, which necessitated either obtaining energy from some source or adding considerable capital account to its present plant. The latter course appeared very undesirable on account of the poor location of the plant with respect to fuel supply and condensing water.

Suburban Gas & Electric Co. (Revere) Costs.

	Per Kw.-hr.
Total cost of energy at Revere station, 1915 basis	$0.01460
Estimated cost of purchased energy	0.01383
Cost of purchased energy	0.01150
Saving per kilowatt-hour	$0.000[illegible]

Or an annual saving of $2,695.

The above estimated * cost of purchased energy is made up on the basis of figures used for the Malden Electric Co., with a deduction of $250 for fuel used in heating and of $750 for repairs, making a total of $8,170, which represents a part of the production cost at Revere when energy is purchased.

	Per kw.-hr.
For a production of 3,500,000 kw.-hr., at $8,180, the unit cost comes to	$0·00233
Total	$0·01383

The load conditions at the Revere station were approximately 1,900 kw., and its normal rating 1,440 kw.

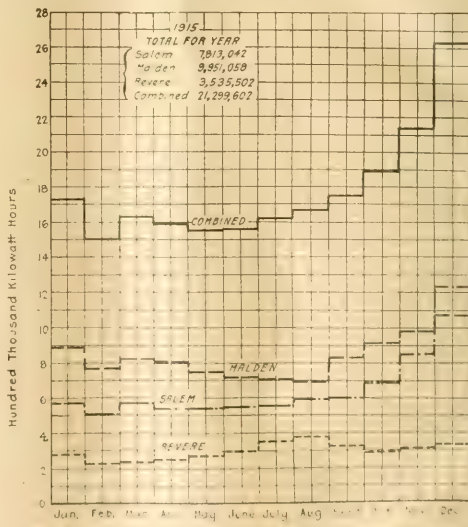


FIG. 2.—ENERGY OUTPUT OF THE INTERCONNECTED STATIONS FOR YEAR OF 1915.

Prior to the construction of the transmission tie line between Malden and Salem energy was purchased from the Malden Company by the Revere Company to take care of the overload conditions during the summer months; but, as stated under the Malden conditions, the load of the Malden Company would shortly have made it impossible for it to continue to assist the Revere Company in this way. As the Salem Company during the summer has surplus capacity, it is in an excellent position to relieve both the Revere and Malden plants at the same time, eliminating the need of a large additional investment at the Revere plant no less than at Malden. At Revere an aqueduct would have had to be constructed had energy not been purchased from Salem or an equivalent source of large capacity.

The total cost of the line (of which details are given in the original article) was $2[illegible]. The income is given in the adjoining table :—

Income† from Tie line Service.

Revenue :		
Malden Company	10,000,000 kw.-hr. at $0·009	$90,000
Revere Company	3,500,000 kw.-hr. at $0·0115	40,250
Total		$130,250

* The estimated cost of purchased energy is the amount paid the transmission company plus expense of running distributing station.

† Income based on taking transmission line investment at $250,000.

Operating Expenses:

Energy purchased by transmission company from Salem, 14,650,000 kw.-hr. at $0.006	$87,900
Labour	8,000
Repairs	1,000
Taxes, 2·5 per cent. on $200,000	5,000
Insurance—fire, employees, public	1,000
Depreciation on $200,000 at 5 per cent.	10,000
Interest on $250,000 at 6 per cent.	15,000
	127,900
Net income of transmission company	$2,350

From the foregoing analysis it appears that the profit to the Salem company [illegible] consumption 1·9 lb. per kilowatt hour.

INDUSTRIAL RECONSTRUCTION.

We have received from Messrs. Benn Brothers (Ltd.) the following manifesto, which has been signed by many prominent people. Certain general considerations and suggestions are first put forward, and these are followed by the outline of a scheme for further study. We comment on these proposals in our Editorial Notes.

General Considerations.

To meet the urgent needs of the times, it will be necessary to increase considerably our efforts to develop our industries on the following lines:—

1. The mobilisation of each industry for common action.
2. A greater degree of co-operation between manufacturers.
3. Co-operation between labour and capital and the avoidance of industrial strife.
4. A more complete association between scientific institutions and traders.
5. Education better adapted to our commercial needs.
6. Each industry to be studied *as a whole*, and freed from unnecessary [illegible] competition.
7. Every trade to present a united front to foreign competition.
8. Output regarded as a duty by both capital and labour.
9. Encouragement by the Government of the activities of traders, with a minimum of interference.

The necessity for greatly increasing the national output is so imperative that the matter cannot be left to chance, and the responsibility cannot remain with individuals. It thus becomes necessary to adopt some national scheme which shall ensure the securing of these objects. The interests of both capital and labour are equally at stake.

Although we depend upon our industries they have no place in the Constitution. There is a [illegible] interest in trade and industry, which is not at present recognised.

It is therefore suggested:

(a) That a national organisation on lines such as those suggested by the Whitley Report, should be established which will retain all the [illegible] qualities of our present individualistic system and add to them the necessary [illegible] to create greater activity.

(b) That such an organisation [illegible] to provide for the representation of all classes of persons engaged in a given industry.

(c) That industry should [illegible] be enfranchised, and every man and woman, employer and employed, given a vocational or trade vote by means of which the representation would be [illegible].

(d) That every citizen should have the right to register with some [illegible] trade association, or trade union, and thus an industrial or vocational register properly [illegible] would be produced.

(e) That trade councils should be created in each industry [illegible] the trade associations and the trade unions. Such councils [illegible] upon a [illegible] representative basis, would be able to [illegible] of the [illegible] their respective industries.

(f) That all questions [illegible] between the Government and a given trade should be delegated to the council of that trade [illegible] have power to deal with them.

(g) That questions of [illegible] education, trade schools, [illegible] export, [illegible] tariffs, &c., &c., should be settled in each trade by the [illegible] of that trade, and [illegible] spent [illegible] these matters [illegible] through the trade [illegible].

We feel that the time has come when the [illegible] matter should take a more [illegible] and practical [illegible] and we therefore put forward the following heads as a basis for further study.

[illegible]

1. *[illegible]*—A [illegible] would [illegible] the organisation of [illegible] of capital and labour. [illegible] national [illegible] by Government departments.

2. *The Government.*—A department should be established [illegible] representative trade [illegible]. It should be [illegible] by an advisory council [illegible] of the [illegible] councils. It should [illegible]:—

(a) Exports [illegible].
(b) [illegible].
(c) Commercial education.
(d) [illegible].
(e) [illegible].
(f) [illegible].

3. *[illegible]*—Every [illegible] should have the right to register as a [illegible] association or chamber of trade.

4. *Trade Unions and [illegible]*—[illegible] trade councils. They would maintain their existing constitution and carry on thir varied objects as now. Their freedom of action for their own purposes [illegible].

5. *Trade Councils.*—A council [illegible]:—

(a) Members [illegible].
(b) Members [illegible].
(c) Members [illegible].

6. *[illegible]*—[illegible] it would have [illegible]

[illegible]

J. C. Maxwell Garnett, M.A., Dean of the Faculty of Technology, University of Manchester.
William Garnett, D.C.L.
John Goodman, Professor of Engineering, University of Leeds.
J. Ernest Greaves, J.P., D.L., Lord Lieutenant of Carnarvon.
E. H. Griffiths, M.A., Sc.D., F.R.S., Vice-Chancellor of the University of Wales.
James Heath, Bart.
Gisbert Kapp, M.Sc., Professor of Electrical Engineering, University of Birmingham.
A. W. Kirkaldy, M.Com., Professor of Finance, University of Birmingham.
F. J. Leitch.
E. A. Lewis, M.A., D.Litt., D.Sc., Professor of Economics and Political Science, University College, Aberystwyth.
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William Morgan, B.Sc., Professor of Automobile Engineering, University of Bristol.
John Munro, M.Sc., Professor of Mechanical Engineering, University of Bristol.
A. P. Newton, M.A., D.Litt., B.Sc., Secretary of the Imperial Studies Committee.
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W. E. B. Priestley, Kt., M.P.
H. R. Procter, D.Sc., F.I.C., Professor of Applied Chemistry, University of Leeds.
Pierce F. Purcell, M.A., M.A.I., Professor of Civil Engineering, University of Dublin.
W. Ripper, D.Sc., C.H., Vice-Chancellor of the University of Sheffield.
Hugh Ryan, M.A., D.Sc., Professor of Chemistry, University College, Dublin.
A. W. Scott, M.A., Professor of Science, St. David's College, Lampeter.
T. A. Smiddy, M.A., Professor of Economics, University College, Cork.
Daniel M. Stevenson, Bart., LL.D., D.L.
Wilfrid Stokes, K.B.E.
Henry Stroud, M.A., D.Sc., Professor of Physics, Armstrong College, Newcastle-on-Tyne.
W. E. S. Turner, D.Sc., Professor of Glass Technology, University of Sheffield.
Miles Walker, M.A., M.I.E.E., Professor of Electrical Engineering, University of Manchester.
W. H. Watkinson, M.Eng., Professor of Engineering, University of Liverpool.
Julius Wertheimer, B.A., D.Sc., F.I.C., Dean of the Faculty of Engineering, University of Bristol.

The Editors of the following Trade Journals:

[illegible] Welding Journal.	Hardware Trade Journal
[illegible]	Hatters' Gazette
Aeroplane.	Illuminating Engineer.
Architect.	India Rubber Journal.
[illegible]	Iron and Coal Trades' Review
[illegible] Journal.	Laundry Journal.
	Laundry Record.
[illegible]	Light Car
[illegible]	Light Car and Cyclecar
[illegible]	Managing Engineer
[illegible]	Marine Engineer
[illegible]	Metal Industry
[illegible]	Mining Journal
[illegible]	Motor
[illegible]	Motor Cycle
[illegible]	Motor Cycle and Cycle Trader
[illegible]	Motor Cycling
[illegible]	Motor Ship and Motor Boat
[illegible]	Motor Traction
[illegible]	Motor Trader and Review
[illegible]	Newspaper World
[illegible]	[illegible] Review
[illegible]	[illegible] Instrument Maker
[illegible]	Photographic Dealer
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
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[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

[illegible]

Charles Boot, Yorkshire Federation of Building Trade Employers.
Arthur J. Bowen, Birmingham Builders' Association.
J. Bradbury, Master Silversmiths' Association, Sheffield.
Thomas Brearley, Lancashire and Cheshire Association of Basket Makers.
Charles Breeden, Birmingham and District Master Gas Fitters' Association.
C. C. Broad, National Federation of Building Trades' Employers, Malvern.
Harry Buchanan, Bristol Electrical Contractors' Association.
D. Carson, National Association of Master Farriers.
J. S. Cornwell, Bedstead Manufacturers' Association.
Thomas Critchley, Liverpool and District Mineral Water Manufacturers' and Bottlers' Association.
George Crossley, Oldham and District Master Plumbers' Association.
Arthur S. Culliwick, Midland Lock and Latch Manufacturers' Association.
Andrew Dargavel, Federation of Master Process Engravers.
G. J. Davis, Southern Counties Master Builders' Federation.
H. Ferguson, Kirkcaldy and District Master Joiners' Association.
Thos. Foster, North Western Federation of Building Trades' Employers.
George Geary, Hinckley and District Boot Manufacturers' Association.
Thos. Graham, Edinburgh, Leith and District Master Slaters' Association.
Ernest Griffiths, M.I.Mech.E., National Association of Master Heating and Domestic Engineers.
John Hanson, Burnley and District Building Trades Employers' Association.
W. Howard Hazell, London Master Printers' Association
R. B. Henry, Belfast Builders' Association.
J. Hewitt, Barnsley and District Colliery Owners' Association.
J. Higson, National Association of Master Painters and Decorators of England and Wales.
Fred. B. Horn, London Cane and Willow Workers' Employers' Association.
Robert L. Johns, Newport Master Printers' Association.
Joseph Johnstone, Scottish Furniture Manufacturers' Association.
Reginald H. Keatinge, Master Painters' Association of Ireland.
E. Keighley, Burnley and District Engineering Employers' Association.
William B. Kingham, West End Master Bootmakers' Association.
R. Leach, Fleetwood and District Building Trades Employers' Association.
George Lyall, Edinburgh Branch of the Electrical Contractors' Association of Scotland.
H. E. D. Mabbott, Sheet Metal Workers Employers' Association, Manchester.
James G. McAjec, Belfast Master Bootmakers' Association.
Joseph T. McArthur, Master Painters' Association of Scotland.
L. A. McGeoch, Ironmongers' Federation.
James J. McKeown, Belfast Electrical Contractors' Association.
James Melville, Scottish Reinforced Concrete Contractors' Association.
J. W. Musselwhite, Basingstoke Master Builders' Association.
Tom Phillips, South Wales and Mon. Iron and Steel Makers' Association.
J. Percy Smith, Nottingham Lace Manufacturers' Association.
William Somers, Stirling and District Master Joiners' Association.
Henry H. Spittal, Scottish National Building Trades Employers' Federation.
J. King Stewart, Fertiliser Manufacturers' Association.
Walter R. Stokes, Employers' Federation of Cane and Willow Workers of Great Britain and Ireland.
D. B. Strang, British Rope Manufacturers' Association.
Thomas Thompson, Monumental Sculptors' Association of Belfast and District.
James S. Waterston, Scottish Alliance of Master Printers.
S. H. Webb, Leicester and District Building Trades Employers' Association.
Thomas S. Whitfield, Marl Owners' Association, North Staffs.
J. E. Wilkinson, Southport and District United Building Trades' Association.
Watkin Williams, Cardiff Master Builders' Association.
Thos. B. Wright, Electrical Contractors' Association of Scotland.
Secretary, F. W. Galton, Bean Brothers (Ltd.), 8, Bouverie-street, E.C. 4.

A meeting will shortly be arranged for the further explanation of these proposals, and this will be announced in due course. In the meantime communications may be addressed to Mr. Galton.

CORRESPONDENCE.

"A PEACE KITE."

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your [illegible] issue the first par. of your "Round Table" notes, headed "The Latest Peace Kite," is likely to give the impression that I am connected either with Germans or their advocates, and I shall be much obliged if you will be so good as to correct such impression.

I have not been connected with any L. D. Motor Co. or with the production of [illegible] machines for 10 or 12 years.

The person E. N. Langdon Davies mentioned has, unfortunately, been [illegible] upon me by nature as a brother, but that is the only connection of any kind. I am of opinion that he and his fellow German sympathisers should have been

suppressed by law long ago: but apparently the Government does not see fit to remove them.

I shall be extremely grateful if you will kindly insert this letter in your next issue, and use every endeavour in your power to dissociate me from those degraded freaks known as "Pacifists," [illegible].

Although I am too old for military service, still "they also serve," &c.—I am, &c.,

London, Oct. 8. WALTER LANGDON-DAVIES.

[We regret that the note to which Mr. Langdon-Davies refers should have given the impression that he is connected with [illegible]. There was certainly no such intention—indeed quite the reverse. ED. E.]

NON-MAGNETIC WATCHES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: For the last 30 years I have used non-magnetic stop watches of fairly good quality, costing in steel or silver cases from £7 to £15. These watches are Swiss made, and bought from firms of the highest class, but they are poor time-keepers, have a tendency to stop, and seldom run more than two years without an overhaul, which costs at least £1, and takes from six months to a year to carry out. At present it is impossible to get any work done to them, and as a stand-by I have lately bought a second-hand split seconds stop watch, 11 years old, [illegible] steel balance spring, and steel pallets and [illegible] wheel, which gives most excellent time-keeping, and [illegible].

The question is whether it is worth while to carry a non-magnetic watch when erecting electrical machinery. The text-books are not clear in the matter, but seem to suggest that the [illegible] get magnetised and cause trouble. These [illegible] are not used in modern watches, and it will be interesting to see whether the watch with steel pallets will be affected.

Modern electrical machines have not excessive external fields, but one would expect to find trouble when using permanent magnet instruments and insulation testers of the megger type as one has to get very close to them.

It would be interesting to have the experience of your readers.

The stop watch part, [illegible] the beautiful split seconds work, has never given [illegible] trouble, although most of the parts are of steel.

What is the effect of the steel case?

When tried with a compass the silver case watch above mentioned shows strong [illegible] and a small compass laid over the balance [illegible].

A steel case non-magnetic [illegible] has the case and stop watch mechanism [illegible], but the compass does not [illegible] balance.—I am, &c.,

London, Oct. 8. H. RAVENSHAW.

BUREAU OF STANDARDS FOR BIRMINGHAM.

Prof. [illegible] delivered an address last week before a meeting [illegible] "The Establishment of a Bureau of [illegible] for the Midland Area."

[illegible]

work was a paying proposition only where a high [illegible]

essential for nearly all that concerned military [illegible]

only difference being that in the rougher types the [illegible]

required.

all attempts at piecemeal manufacture would be [illegible]

metric system ever come into general use with those comm[illegible] would be of the greatest advantage to the manufacturer [illegible]

could be satisfactorily settled only by pra[illegible]

trade, much valuable information would [illegible] their use. To be of the fullest value to [illegible]

scale products on scientific lines, and for [illegible]

ments, and to obtain for the manufa[illegible]

[illegible]

LEGAL INTELLIGENCE.

The Kensington and Notting Hill Companies' Arbitration.

In our last issue we gave a brief summary of the award of Mr. James Swinburne, F.R.S., in the arbitration between the Kensington & Knightsbridge Electric Lighting Co. and the Notting Hill Electric Lighting Co. The following are the terms of the award:—

1. Clause 3 of the agreement of 1900 means that the respondents are to take from the joint station at Wood-lane all the electrical energy over and above that generated by its own generating station at Bulmer-place that they require.

2. Though the privileges granted by the Kensington & Notting Hill Act of 1899 were not specifically extended by the Act of 1909, the companies are justified in taking energy from Wood-lane for the supply of "fringe" consumers; and the agreement of 1900 binds them to do so, as long as any of the stock mentioned in it is outstanding, to the full extent to which they would have been bound had the Act of 1899 specially entitled them to use Wood-lane supply for "fringe" or outside areas.

3. The respondents' business is all their supply of electrical energy, including any supply of energy which was nor is not duly authorised by Act of Parliament.

4. The respondents made no secret of taking energy from outside sources, but the claimants did not know, or its officers did not realise until recently, that this involved any question arising out of the agreement of 1900; and the claimants did not recommend taking outside supply, nor did they condone any infraction of the agreement. The claimants have suffered damage.

5. By the agreement of 1900, so long as any of the stock shall be outstanding, each of the two companies shall from time to time take from the joint station all such electrical energy in excess of that generated in its own station or stations existing within what was its statutory area in 1900, as such company may require for the purpose of supplying energy in accordance with the provisions of the principal agreement or such other provisions as may from time to time be agreed upon between the two companies or settled unanimously by the committee.

6. In accordance with clauses 1, 2, 3 and 4, the respondents shall pay the claimants the sum of £189 (One hundred and eighty-nine pounds) damages in respect of the supply in Kensal Town in 1909; and in respect of the costs of this branch of the reference, a sum equal to one-tenth of the total taxed costs of the claimants, in the whole of the proceedings before me. But if it should be held that I am wrong in my view of the construction of the agreement concerning the supply in Kensal Town in 1909 the respondents shall not pay the said £189 or corresponding costs, and the claimants shall pay the respondents a sum equal to one-tenth of the total taxed costs of the respondents.

7. In accordance with clauses 1 and 2 and 4, the respondents shall pay the claimants the sum of £1,661 (Sixteen hundred and sixty-one pounds) damages in respect of the supply in Kensal Town since 1909, including 1916; and in respect of the cost of this branch of the reference, a sum equal to seven-eights of the total taxed costs of the claimants in the whole of the proceedings before me. But if it should be held that I am wrong in my view of the construction of the agreement concerning the supply in Kensal Town since 1909, the respondents shall not pay the said £1,661 or corresponding costs, and the claimants shall pay the respondents a sum equal to seven-eights of the total taxed costs of the respondents.

8. With regard to Hammersmith, I find that:

(a) It is my duty to deal with this question, and I treat it as if it were a separate arbitration, its costs being one-fortieth of the whole taxed costs. (b) The supply at Hammersmith is a breach of the agreement of 1900; and clauses 1, 2, 4 and 5 of this award apply to this case also. (c) In accordance with clauses 1, 2 and 4, the respondents shall pay the claimants the sum of £50 (Fifty pounds) damages in respect of the supply in the Hammersmith district up to and including 1916; and in respect of the costs of this part of the reference, a sum equal to one-fortieth of the total taxed costs of the claimants, in the whole of the proceedings before me. But if it [illegible] held that I am wrong in my view of the construction of the agreement concerning the supply in Hammersmith, the respondents shall not pay the said £50 or corresponding costs, and the claimants shall pay the respondents a sum equal to one-fortieth of the total taxed costs of the respondents.

9. I further [illegible] that the cost of the award be paid by the respondents [illegible] If not, it shall be paid by the respondents in the proportion of the damages payable by them, the rest being paid by the claimants.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

[illegible]

12,44[illegible]

[illegible]

discharge electrode comprising a plurality of conductor members extending parallel to one another and to the opposing electrode surface, said conductor members being arranged in polygonal order and in such spaced relation that each member forms with its adjacent members an obtuse interior angle for the purpose of reducing the electric field intensity adjacent to each conductor member by the influence of adjacent members.

12,690 DEVENTER, H. R. VAN. Portable electric generator lamps. (31/7/15.) 101,422.

13,342 JONES, E. H. Method of and means for depositing metal by an electric arc. (20/9/16.) (Cognate Application, 3,864/17.)* 109,321.

13,664 RICE, H. A. Combined electric stoves and toasters. (22/9/15.) 101,634

13,746 LAMBOURNE, R. Electric signalling systems. (27/9/16.) (Cognate Application 1,233/17.) 109,325.

16,855 LAMKIN, A. E. Method of and means for cooling the sparking plugs of internal combustion engines. (24/11/16.) 109,345.

17,983 B.T.-H. Co. (G. E. Co.) Production and maintenance of high vacua and the purification of noble gases. (14/12/16.) 109,358.

Consists in heating a metal of the rare earth group (thorium and zirconium) in contact with the gas.

18,005 CASELLA, S. L. Machines for making battery cups, and methods of manufacture

1917 SPECIFICATIONS.

414 TRIER, V. A. Electric starting devices for internal combustion engines. (9/1/17.) 109,376.

3,976 MATTHEWS, W. C. Sparking plug for internal combustion engines. (19/3/17.) 109,403.

6,255 IGRANIC ELECTRIC CO. (Cutler-Hammer Manufacturing Co.). Controllers for electric motor circuits. (2/5/17.) (Addition to 103,441.) 109,418.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

September 14, 1917.

13,196 MORRIS, LISTER & ROEBUCK. Apparatus for detecting variation in a magnetic field.

13,221 MJELVA. Electric ovens.

13,225 SELECTIVE SIGNAL CO. & LYONS. Apparatus for reception and utilisation of electric current impulses for wireless, &c., telegraphy and telephony.

September 15, 1917.

13,260 AUTOMATIC TELEPHONE MFG. CO. & REMINGTON. Electric signalling systems for mines, &c.

September 17, 1917.

13,265 BRITISH INSULATED & HELSBY CABLES (LTD.) & BUTCHER. Manufacture of extended metal rods and bars

13,282 COTTINGHAM & SMITH. Sparking plugs

13,285 WATSON, ETCHELLS & GREAVES. Electric furnaces.

13,311 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Armatures

13,318 TURNBULL. Electric ignition apparatus for internal combustion engines.

13,328 MARKS. (S. A. Italiana J. Ansaldo & Co.) Electric furnaces, &c.

13,331 WIRT. Holder for incandescent lamps.

13,332 ALLMANNA SVENSKA E. K. A. B. & LINDBLOM. Limitation of movement in electric cranes, &c.

September 18, 1917.

13,344 SCHOFIELD. Securing shade covering to electric lamps.

13,353 RHODES. Magnetic seaplane torpedo.

13,358 HALPIN & LANCASTER. Electric tramway trolley wire finder and trolley wheel adjuster.

13,369 PARIANI. Sparking plugs.

13,378 ALLEN, MAYES & SPENCER. Sparking plugs.

13,336 HOLLAND. Distributors for h.t. ignition systems.

VOLUNTEER NOTICES.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

HEADQUARTERS: Balderton-street, Oxford-street, W. 1.

Orders for the Week.

Lieut.-Colonel C. B. CLAY, V.D., Commanding.

Officer for the week.—Sec.-Lieut. E. A. Ullmann.

Next for Duty.—Sec.-Lieut. C. E. Campbell.

Promotions, Reversions, &c.—187 Cpl. Ismay, W. E., to be Sergeant, 291 A/Cpl. Brooks, J. W., reverts to ranks; 130 Sapper Robinson, T. W., to be Corporal. All in No. 3 Company dated 29/9/17, 10 Bugler and A/Cpl. Niepold, A. G. (Band) to be Corporal; 118 A/Cpl. Gerry, S. H., to be Corporal and 432 Sapper Jackson, A. E., to be Corporal. Both in No. 2 Company, dated 6/10/17.

Monday, Oct. 15th.—Drill and Elementary Bridge Construction for No. 3 Company, Left Half Company, 6.30. Signalling Section, 6.30. Recruits' Drill, 6.30.

Tuesday, Oct. 16th.—Physical Drill and Bayonet Fighting, 7.30.

Wednesday, Oct. 17th.—Drill and Elementary Bridge Construction for No. 1 Company, 6.30.

Thursday, Oct. 18th.—Drill and Elementary Bridge Construction for No. 2 Company, 6 [illegible] Signalling Section, 6.30. Ambulance Section, 6.30.

Friday, Oct. 19th.—Drill and Elementary Bridge Construction for No. 3 Company, Right Half Company, 6.30.

Saturday, Oct. 20th.—Commandant's Parade for Route March and Drill. Parade at Headquarters 2.45 p.m. Uniform. A and B N.C.O.'s and men are reminded that one Route March per month is compulsory.

Musketry.—The Range at Belvedere-road will be open every Tuesday, Wednesday and Thursday evening from 5.30 to 7. All N.C.O.'s and men who have signed the "A" and "B" agreements are required to attend during this month to re-classify in order to enable the Corps to obtain the Capitation Grant. Preference will be given to these men in firing. This does not apply to those who hold the proficiency badge.

Armlets.—The new blue armlet can now be obtained at Headquarters, and every enrolled Volunteer must obtain one without delay. At the same time all old red armlets must be returned. Armlets must be worn when attending drills in plain clothes.

Medical Examination.—The Medical Officer will attend at Headquarters for this purpose every Thursday at 6.

COMMERCIAL & INDUSTRIAL SECTION.

Commercial Intelligence.

At last week's meeting of the Advisory Committee of the Board of Trade on Commercial Intelligence, a report on the work of the Department of Commercial Intelligence during the third quarter of 1917 was submitted.

The President of the Board of Trade (Sir A. Stanley) and Sir A. H. Steel Maitland made statements as to the reconstitution on an extended scale of the Department under the arrangements recently concluded between the Board of Trade and the Foreign Office.

The Committee also considered questions relating to the promotion of British trade and shipping interests in Latin America, and a report of a special inquiry into the electrical trade in Spain and Portugal.

* * * *

Status of Chambers of Commerce.

A meeting of Chambers of Commerce was held yesterday in London for the purpose of considering their present position and status. The Foreign Office wants the Chambers to undertake important work in connection with the distribution and dissemination of commercial intelligence, but stipulates that the Chambers must be incorporated, have a full time secretary, and an annual subscription of not less than two guineas. Many Chambers think that the subscription should not be compulsory.

* * * *

Mineral Resources of the Empire.

It has been definitely decided to provide the necessary machinery for the protection and advancement of the economic welfare of the metal and mineral industries of the Empire. Arrangements are being made for the formation of a body to be called the Imperial Mineral Resources Bureau, which will be representative of the different parts of the Empire.

[illegible] surveys and departments of mines in nearly all [illegible] and there are similar departments in some of the British [illegible] but there is no connecting link or central clearing house to [illegible] information on the mineral resources of the Empire, to [illegible] their development [illegible] and to safeguard Imperial [illegible]. The new body is designed to make good this deficiency.

* * * *

Newcastle Chamber of Commerce.

The Chamber appears to be alive to the importance of cheap electric [illegible] industrial purposes. [illegible] last meeting Mr. C. Turnbull, [illegible] the electrical section, asked for the appointment of a sub-committee by the Council to aid the section in giving evidence before the Board of Trade Electric Power Supply Committee as to the [illegible] which might be effected by the use of electricity in the [illegible], its effect upon industrial development, convenience of electricity [illegible] and its adaptability to awkward [illegible]. The use of waste heat from coke ovens and blast furnaces for electrical purposes [illegible] also a subject for [illegible] investigation.

After [illegible], Messrs. F. L. [illegible], H. Peile and E. C. [illegible] were appointed.

* * * *

Technical and Commercial Libraries.

At the [illegible] meeting of the [illegible] Association last week [illegible] Dr. [illegible] made an interesting speech on the [illegible] of research libraries and the importance of collecting [illegible] information.

Dr. [illegible] said that one of the features of the programme of the Association which had particularly appealed to him was the movement which was [illegible] making considerable progress, for the [illegible] of technical and commercial libraries and for the setting up of [illegible] libraries [illegible] to suit the particular needs and industries of the districts. [illegible] If we are to pay for the war and [illegible] we want the different trades and districts of the country themselves to throw their hearts and [illegible] into their work, and [illegible] to organise more and more for the [illegible] and dissemination of useful and necessary information. I know that [illegible] the war this country has been handicapped to a [illegible] degree by the absence of necessary scientific and industrial information of a [illegible] kind, and what I mean by [illegible] kind of information [illegible] can be made use of by a man who is competent in the particular [illegible]. A good deal of our information had been such that it would not meet the needs of a commercial community. For instance, the war had [illegible] prived us of certain necessary [illegible] minerals and of the [illegible] of how to work them. We had in many essential industries allowed ourselves to become dependent upon German and Austrian manufacturers. However expert we might be in the production of [illegible] part of a machine, we were [illegible] parts had to come from other countries. The Imperial Conference had given careful consideration to this aspect [illegible] proposals would be made. In these islands and our possessions we had all the essential materials of industry, but we had up to now neglected them. This was due to the fact that the [illegible] testing for trade processes had not been undertaken. [illegible] on Scientific and Industrial Research [illegible] in particular industrial processes, but we could never [illegible] of our resources unless the trades themselves and the [illegible] they flourished took an active part in the work. [illegible] could do a valuable work by placing information useful to the [illegible] of various districts at the disposal of [illegible]. In this there was a severance between the universities and the [illegible] munity. We had to bridge that gap [illegible] by having the post-graduates from the universit[illegible] in special workshops. A working relationship between higher educational authorities and the business community was [illegible] industrial progress.

The President of the Association, Mr. J. W. [illegible], said that commercial libraries were [illegible]. Technical libraries they always had [illegible] developed in several directions to become efficient aids to the [illegible] manufactures of this country. The possibilities of the technical [illegible] in aiding research, discovery and invention had never been fully [illegible] in this country, and as to the commercial library, he did not [illegible] that any question would arise [illegible] the urgent need of it.

Mr. G. A. Pitt, [illegible] Public Libraries [illegible] a Paper on commercial [illegible] that in [illegible] and industrial areas there was a need for the est[illegible] accumulation and diffusion of information [illegible] and it seemed to him that the public librar[illegible] available. Special libraries of that kind had been opened in [illegible] and Liverpool; others at Manchester, Leeds and Bradford w[illegible] be opened. [illegible] last 30,000 visits had been made by business people to the local [illegible]. Some of the information [illegible] reference and Parliamentary [illegible] too, applications had been made to the Department of Commercial Intelligence of the Board of Trade or other Government [illegible] to allied and neutral countries, for assistance in matt[illegible] unusual difficulty.

Mr. Pitt suggested that the Commercial Intelligence Department of the Board of Trade [illegible] control of public commercial libraries in [illegible] ments in libraries in smaller towns. [illegible] Departments and the libraries.

[illegible] Manchester Libraries Co[illegible] extending their Royal Ex[illegible] City Commercial Library.

[illegible]

* * * *

Chemical Trades Reorganisation.

[illegible] with the position of the [illegible] of Munitions), Sir Will[illegible]

[illegible] trade may be ena[illegible] of the chemical industry.

ELECTRICITY SUPPLY.

EXTENSIONS.

Bolton.—The Finance Committee has decided to apply for sanction to borrow £60,000 for plant extensions at the Back-o'-th'-Bank electricity works.

Halifax.—Last week the Tramways and Electricity Committee submitted the report of Sir John Snell in regard to the acquisition of a site for new electricity works. Sir John expressed the opinion that the Corporation had been well advised to acquire a new site now, and recommended that the option be exercised and the purchase of the Sterne Mill and Wood House site be completed. In accordance with this report the Committee stated that the option had been exercised and the site acquired.

Sheffield.—The general manager of the electricity undertaking has been authorised to proceed with the renewal of the equipment in No. 1 sub-station at Neepsend power house, at a cost of £2,000.

Stafford.—The Council has decided to purchase land adjoining the electricity works for extension purposes.

GENERAL.

Birkenhead Electricity Employees' Strike.—The stokers, engine drivers and trimmers employed at the Birkenhead electricity works came out on strike on the 4th inst., in consequence of their dissatisfaction with the award made in March by the Industrial Commissioners in regard to the engineering and allied trades.

Arbitration proceedings at the men's desire, took place on Aug. 16, and the arbitrator (Mr. E. Forbes Lankester, K.C.) awarded drivers 11s., stokers 10s., and trimmers (not employed prior to June, 1915) 8s. 2d. per week over pre-war rates. The men claimed 15s.

By the aid of voluntary workers the tramway service has been maintained.

Birmingham.—The Board of Trade has extended for one year from Sept. 16, 1917, the time limited by the Birmingham Corporation (Quinton) Light Railway Order, 1913, for the purchase of lands and completion of works.

Board of Trade Electric Power Committee.—At the last meeting of Stretford Urban Council it was reported that the Clerk had submitted to the Chairman of the Legal and Parliamentary Committee a statement of points which it was desirable should be given in evidence by the representatives of the Urban District Councils Association before the Board of Trade Electric Power Supply Committee. The following is a summary of the statement:—

(1) Principle of distribution by local authorities should be retained; (2) that no charge should be made on the general body of ratepayers for the benefit of electricity consumers and that the outstanding debt of any small superseded station should be taken over by the super-station authority; (3) that the super-station authority should be under obligation to supply energy in bulk; (4) that the super-station authority should be under obligation to supply energy to local authorities at uniform rates; (5) large power consumers should be supplied through the local authority and not direct from the super-station authority; (6) local authorities should have preponderance of representatives on super-station authority.

The Council approved the statement.

Braintree.—The Urban Council has decided to apply to the Board of Trade for a provisional order, and to oppose the proposed application for an order by the Crittoll Mfg. Co.

Colchester.—Five additional employés of the electricity department have joined H.M. Forces, and three of the men have been granted the usual allowances, but no allowances will be made to the two who were not in the Council's service previous to the outbreak of war.

Electricity Works Employees' Wages.—At the meeting of Islington Borough Council on Friday it was reported that on July 27 the employees of the electricity department made a demand for an immediate increase of wages of 10s. per week.

Subsequently the men gave notice to terminate their employment on Aug. 16, but the Chief Industrial Commissioner intervened and intimated to the men's representative that the notice to terminate their employment must be withdrawn, as the question, viz. the application for an immediate increase of wages of 10s. per week, had been referred to the Committee on Production for determination.

After consideration of the statements and arguments submitted by the parties interested the finding of the Committee on Production was issued on Sept. 13, and was to the effect that the war wage advance to the men concerned should be increased to 12s. per full ordinary week as from the beginning of the first full pay in September, 1917, and the amounts thereby awarded were to be regarded as war wage advances and were to be recognised as due to, and dependent on the existence of, the abnormal conditions prevailing in consequence of the war.

The annual cost to the Council in giving effect to the award will be approximately £1,300, whereas if the men's application for an increase of wages of 10s. per week had been granted the annual cost to the Council would have been approximately £2,200.

The Council, as well as the Stepney Council, have concurred in the opinion expressed by Hammersmith Borough Council that there should be a federation of electric supply authorities in London and Greater London to consider rates of wages and conditions of work affecting persons engaged in the generation and distribution of electricity.

Marylebone (London) Electric Supply Committee has informed the Chief Industrial Commissioner that, having come to satisfactory arrangements with the employees, it sees no reason to re-open the question at present.

Faversham.—The electric supply sub-committee estimate that £493 will be required from the rates next half-year in order to balance the accounts. It is recommended that the charge for current be increased by ½d. a unit.

Hackney (London).—At the meeting of the Council last week the accounts of the electricity undertaking for the year ended March 31 last were approved.

Ald. Payne said he thought the Council should express appreciation of the results achieved through the constant and arduous work of their engineer (Mr. L. L. Robinson) and the whole of his staff. The serious deficiency of a year ago had been turned into a substantial profit, and the accumulated surplus been increased by something like £7,000.

Hove.—The Board of Trade has extended until Aug. 7 the time limited by the Hove Corporation Act, 1912, for the completion of the overhead equipment and other apparatus for working trolly vehicles on routes authorised by such Act.

Kingston-on-Thames.—The Corporation are appealing to light consumers to use less electricity.

The demand upon the electricity works for electric power has greatly increased and has now reached the utmost capacity of the present machinery. Traders and private consumers are, therefore, asked to reduce their consumption of electricity for lighting, heating and motors to the lowest possible limit between 4 and 8 p.m. on all week-days except Saturdays.

Lewes.—Last week the Highways and Works Committee reported that they considered the price asked by the gas company for lighting 36 lamps was excessive, and it recommended that instead of accepting the gas company's offer the Council should arrange for 30 temporary lamps to be lighted by electricity.

The cost of the installation was estimated at £74. 7s. 6d., and energy was to be supplied at the rate which was charged for lighting in Southover High-street.

Councillor FARNCOMBE mentioned that the 30 electric lights would be placed in main streets. It was estimated that the cost of 36 gas lamps would have worked out at about £135, while the expenditure on the 30 electric lamps would amount to £84. 7s. 6d., so that a saving of £30 would be effected by the use of electricity.

The recommendation was adopted.

Liverpool.—The Corporation are recommended to sanction the following increases of salary:—

Tramways and Electric Power and Lighting Department.—Mr. C. W. Mallins (general manager), from £1,250 to £1,500; Mr. T. Coole (engineer's assistant), from £400 to £500, increasing in 12 months to £550; Mr. T. Ridyard (rolling stocks and works superintendent), from £400 to £500, increasing in 12 months to £550.

Electric Supply Department.—Mr. H. Dickinson (city electrical engineer), from £1,500 to £1,600; Mr. P. J. Robinson (superintendent engineer of stations), from £500 to £700, Mr. Robinson to be appointed chief engineering assistant; Mr. L. Breach (assistant electrical engineer), from £370 to £425, Mr. Breach to be appointed engineering assistant.

City Lighting Engineer's Department.—Mr. A. G. Smith (city lighting engineer), from £500 to £550.

City Engineer's Department.—Mr. J. A. Brodie (city engineer and surveyor), from £1,700 to £2,000; Mr. F. A. Cooper (deputy city engineer), from £600 to £650.

Marylebone (London).—The Council has been recommended to increase the salary of Mr. E. J. Jennings, secretary and accountant of the electricity department from £500 per annum to £525 per annum, and thence rising by annual increments of £25 to a maximum of £600 per annum and the salary of Mr. C. H. Smyth, mains engineer, from £500 per annum to £525 per annum, and thence rising by annual increments of £25 to a maximum of £600 per annum.

Perthshire.—In reply to an inquiry sent out by the Board of Trade Electric Power Supply Committee, the Perth County Council has sent a reply to the effect that

There are no electric supply undertakings in the county either municipally owned or owned and worked by private commercial companies, but there are a few undertakings privately owned, mostly very small.

The small undertakings are not in a position to give supplies, except that the undertaking at Blair Castle supplies the villages of Blair Atholl and Bridge of Tilt with electric current for lighting.

It is believed there is a prospective demand for electric supply in the county; existing undertakings cannot meet this demand. Speaking generally, it is believed that one scheme for the county would be most advantageous, but any scheme should be under commercial management with proper safeguards.

Generally speaking, no advantage has been taken of water power for electric supplies. A number of small supplies of water power have been utilised. It is believed that the waters of Loch Ericht could be usefully and profitably utilised for providing electric supply.

Rotherham.—The salary of the borough electrical engineer and tramways manager (Mr. E. Cross) has been increased by £100 per annum.

Sheffield.—The Corporation proposes to apply for powers to supply electricity to several places in the district surrounding the city, and at the meeting of the Council on the 9th prox. a resolution will be submitted in favour of applying to the Board of Trade for a provisional order authorising the supply of electricity within the rural districts of Wortley, Rotherham, Kiveton Park, Norton, Chesterfield and Clowne, and the urban districts of Stocksbridge, Dronfield and Handsworth.

Southampton.—Last week the Works and Harbour Committee reported that the borough electrical engineer (Mr. H. F. Street) had stated that the increase of load by the additional cranes on the town quay appeared to be beyond the capacity of the transformer, and suggested the alteration of some of the cranes to the standard voltage of the town's supply, so as to reduce the load demanded of the existing transformer. The engineer to the Board is to prepare estimates of the cost of a new power cable, and of altering the installation of five cranes motors from 200 to 400 volts as suggested.

Walsall.—On Monday the Council considered a report by the Electric Supply Committee recommending that for the present no increase in the charges for current be made.

Mr. Hayward said the Committee would reconsider the position in [illegible] months, when they would know something about what their claim would be against the Ministry of Munitions and also would probably know more about what new customers they would have. The future [illegible] of the undertaking depended entirely on the number of new customers they could get.

The Mayor, as vice-chairman of the committee, said that in considering the price the committee realised that an increase in the output would be the salvation of the undertaking, and it was consequently felt that by increasing the [illegible] would be cutting off their main hope of making the [illegible].

Mr. [illegible] the committee were pursuing an unwise policy, [illegible] at present a revenue of £2,000 per annum was being [illegible] the committee would not raise prices in a legitimate [illegible].

[illegible] Mr. Hayward said the committee were negotiating to supply [illegible] would be very big customers, and it was felt it would be unwise to increase the charges at a time when there was a prospect of a [illegible] output which would make it possible to run the undertaking on much more profitable lines.

The report was approved.

West Bromwich.—The salary of the borough electrical engineer (Mr. W. A. Jackson) has been increased from £400 to £500 per annum.

Worcester.—Increases in wages granted to the workmen at the [illegible] works will amount to [illegible] per annum.

York.—The Streets and Buildings Committee has given instructions for the lighting of thoroughfares with electricity where there are supply mains.

ELECTRIC TRACTION.

Blackpool.—An ornamental [illegible] shelter and waiting [illegible] will be erected on the site of the existing shelter at [illegible].

Bootle.—[illegible]

[illegible] 1911 [illegible]

[illegible] £30,000 [illegible]

[illegible] 31, 1916. [illegible]

[illegible] 1917 [illegible]

[illegible] engineer would [illegible]

it. For the overhead equipment Liverpool will pay at the rate of £4 per mile yearly for the upkeep, whereas the rental in the old lease, which had eight or nine years to run, was only £24.

After discussion, the terms of the lease were approved.

Brighton.—The traffic receipts of the Corporation tramways continue to increase, and for the first half of the current year this increase was over £5,000 more than in the corresponding half of 1916.

Doncaster.—On the recommendation of the Tramways Electricity Committee, it has been decided to withdraw workmen's and other return fare and cheap tickets on the tramways.

Dundee.—The tramway manager (Mr. P. Fisher) has been instructed to report on the question of utilising the tramways for the transport of goods.

Exeter.—The tramway fares have been revised and increased owing to the increasing expenses.

Last week the Corporation sanctioned the payment of increased wages to the shed staff.

A fee of 5 per cent. of the value of all property found on the tramcars will be charged when claimed [illegible] be paid quarterly to the employees finding the property.

Gloucester.—The engineer and general manager of the light railways (Mr. F. H. Cotsen) has been instructed to proceed with the extension of the light railway from the Hucclecote terminus to Brockworth, a distance of about three-quarters of a mile.

The authorities concerned [illegible] scheme of hauling in connection with [illegible] worth. It was explained that [illegible] route of the railway authorised [illegible] Railways Order of 1903, which it was proposed that the Corporation should work under a lease from the County Council. These powers have expired, but the County and City Councils will obtain further powers under which the railway might [illegible] poration.

Leith.—The tramway drivers and conductors, male and female, are to receive an extra half-penny per hour.

L.C.C. Tramways.—The [illegible] facilities has caused much dissatisfaction among the [illegible] public.

The new arrangements are very unpopular and have largely [illegible] congestion at certain [illegible] crowding at the termini [illegible] the first car which comes along passengers now have to [illegible] to travel. It [illegible] the traffic [illegible]

Manchester.—At the [illegible] of the [illegible] chairman of the Tramways Committee (Ald. Bowes) complained that the [illegible] the trading departments [illegible]

[illegible] that the Committee would [illegible]

collected would [illegible]

mittee), it [illegible]

Morecambe.—[illegible]

Notts and Derby Tramways.—[illegible]

Railway Electrification.—[illegible]

Sunderland.—The Committee on Production has made the following award as to the wages of tramway employees: -

In lieu of war bonus the men are to receive a war wage advance of 12s. per full ordinary week: the women receive 2s. 6d. (bringing their advance up to 8s. 6d. per week), and boys and youths under 18 receive 1s. 6d. per week in addition to the bonus already paid, bringing them up to 5s. advance. In all cases the bonus or war wage is to be taken into account in calculating overtime.

Tramway Workers Wages.—The recent award of the Committee of Production to Lancashire tramway workers will add £900 a year to the expenses of the Accrington tramways, or the equivalent of 4d. or 5d. in the £. The question of an increase in fares will have to be considered.

The increased wages awarded to the tramway employees by the Committee of Production mean a charge on the Darwen tramway undertaking of between £500 and £600 a year.

TELEGRAPHY AND TELEPHONY.

Automatic Telephony for Buenos Aires.—The question of the automatic telephone concession applied for by Señor Alex. Schwimmer came up for discussion at the meeting of the Buenos Aires Municipal Commissioners recently.

It was deciedd to refer it back to the Intendent (Mayor) with a request for information as to whether the automatic telephone system would give satisfactory results as a public service in the city of Buenos Aires; the possibility and desirability of municipalising the service; or whether it is desirable that the service should be exploited by third parties, by a sole and exclusive concession or by the grant of permits; and in the case of an exclusive concession being contemplated, whether it is desirable to accept either of the two proposals presented (by Messrs. Schwimmer and Jurado respectively) or whether it should be decided by public tender; and what would be the legal situation of the existing telephone companies in the event of an exclusive concession being granted for an automatic service.

German Wireless Station in Argentina—In its issue of Aug. 16 "La Prensa" stated that a few days previously the Ministry of Marine received denunciations from an official of the National Government at Trelew (Chubut Territory) regarding the working of a radiographic station in that district.

The Minister of Marine instructed the officials in charge of the Government's wireless station on the South coast to endeavour to locate the situation of the clandestine station referred to. This they were unable to do. As there was no doubt, however, as to the existence of the station secret orders were given for the cruiser "9 de Julio" to go South and look for it. The cruiser appears to have been successful and the wireless station is said to have been discovered in a business house in the town of Trelew. "La Prensa" stated later that the installation was located in the "Sportsman" bar, and that the constructor of the apparatus was a German named Vergen who alleged that he had been engaged in scientific experiments.

IMPERIAL NOTES.

Australasia.—Sydney Electric Lighting Committee recently recommended the Council, in view of the impossibility of obtaining a stock of consumers' meters at present, to authorise the connection of consumers without meters as a temporary measure until meters can be procured. The charge to be made against the consumer in these cases to be arrived at by a method based on the assumption that [illegible] lamps, &c., are used on the average [illegible].

Mr. R. W. Dalton (H.M. Trade Commissioner in New Zealand) states that there has been [illegible] to procure electric heaters, cookers, irons, &c., in Wellington owing to the restriction of the gas supply in consequence [illegible] stocks of such electrical goods are low, especially as the United States is now an uncertain source of supply.

New Zealand.—Increasing difficulties are being encountered in [illegible] for power and in obtaining [illegible] plant.

[illegible] Council the Electric Light [illegible] to obtain [illegible] station. [illegible]

[illegible] plant [illegible] United States [illegible] available at [illegible] plant was [illegible] due to war conditions.

South Africa.—Cape Town City Council proposes to [illegible] in a position to meet the [illegible] for the next 25 years [illegible] from Cape Town [illegible] required for the tramways. The [illegible] plant [illegible] and of distribution cable [illegible]

MISCELLANEOUS.

Cleaning Warships' Hulls.—The old method of cleaning ships hulls, which was a laborious and lengthy process, is being replaced by electric methods.

Formerly it was customary to allow from 170 to 200 man-days for the work, but recently several electrically-driven machines have been introduced for carrying out the work, and they have been found to be both speedy and effective. Brushes and scrapers are used, and by their means, at a moderate expenditure of electricity in driving the operating motors, an 18,000-ton battleshop can be completely cleaned in 12 hours, and vessels dry-docked after having been cleaned by this method have been found to have remained quite free from any subsequent marine growth.

Cowen Homes for Disabled Soldiers.—The Minister for Pensions (Mr. John Hodge, M.P.) recently visited the Joseph and Jane Cowen Home for Disabled Soldiers and Sailors at Benwell Grange, Newcastle, on Saturday.

There are at present 40 disabled men being trained in the Home in electrical fitting and boot and shoemaking. Mr. Hodge first visited the electrical department, and was informed by Sir Thomas Oliver that the men there had done remarkably well, several of them having secured very nice appointments.

In the boot-making department Mr. Hodge was shown a workman's boot which one of the disabled men, formerly a miner, had made after only six weeks' training. Some of the men were working at the bench, others at stitching machines, and another one, with a deformed left hand, showed how newly soled boots receive their finishing touches on an electrically-driven machine.

Customs Decisions.—According to recent decisions, the import duty upon insulating tape when imported into the Union of South Africa by importers of electrical materials and to be used for insulating purposes, and upon patent quazare electrodes, is 3 per cent. ad val., the whole of the duty being allowed as rebate in the case of British goods.

The import duty on chains for electric starters for motor cars imported into Southern Rhodesia is (a) under General Tariff 20 per cent., (b) on goods produced in the United Kingdom and reciprocating British possessions 17 per cent. and (c) on goods produced in non-reciprocating British possessions 20 per cent.; on adjusters and parts of electric starters for motor cars the duty is (a) 3 per cent., (b) and (c) free.

According to a recent decision, lamps of approved patterns, including incandescent Mazda and new miniature electric lamps, specially fitted and adapted for microscopic work, are admitted into New Zealand free of import duty.

Exports to China.—The "London Gazette" of Oct. 2 contained a further list of persons and bodies of persons in China to whom goods may be consigned from the United Kingdom.

The following are included: Shanghai Municipal Council, Yunnanfu Electric Light Co.

In the entry in a previous list relating to the Municipal Councils of British Allied and Neutral Concessions *and of the International Settlement at Shanghai*, the words in italics are deleted.

Munitions Tribunal Case.—Last week the Belfast Munitions Court considered the claim by six electricians against Belfast Corporation.

The claim of Arthur Clarson was treated as a test case. Clarson alleged that the Corporation contravened the Munitions of War Acts by a lock-out in connection with a difference as to rates of wages, such differences having to be reported to the Board of Trade and 21 days having elapsed from the date of such report which had not been referred to the Board of Trade for settlement.

Counsel for plaintiff (Mr. Black) said the men affected were those engaged in looking after the overhead tramway wires. The men were trade unionists and were paid union wages. In May two or three employees joined the army and unskilled men were taken on to do the work in their place. The Union protested and it was decided that the new men would [illegible] union rates of pay. The tramways manager (Mr. Moffett) decided in August to pay a lower scale of remuneration than had been paid. The men received notice on Aug. 11, but they were given liberty to apply for work as overhead wiremen at reduced pay. The secretary of the Union notified the Tramway Committee and Mr. Moffett refused [illegible] the men on at union rates pending arbitration.

Clarson said he [illegible] employed by the Corporation for 12 years on overhead work. He [illegible] a member of the Electrical Trades Union and he had been paid [illegible] wages. On Aug. 11 he received notice of dismissal, and on [illegible] 13 he applied at Sandy Row for reinstatement. On the following [illegible] he got a schedule of the rate of wages which was lower than what [illegible] getting. Overtime also was lower and the hours were [illegible] instead of 51. He refused to accept the new schedule.

Mr. Ernest Kelly, secretary of the Electrical Trades Union, denied that the men had [illegible] any notice accepting employment at a reduced scale. A notice of [illegible] given on Aug. 9, by reason of an extension to Aug. 23, [illegible] out.

Mr. Lewis [illegible] Corporation) said that on Sept. 4 the tribunal tried a prosecution brought by the Corporation against certain men in the electricity department who came out in a sympathetic strike on behalf of [illegible], and after an adjournment until Sept. 18 it was reported that the men had returned to work. On Sept. 19 the [illegible] summons [illegible].

The Chairman intimated that he did not consider it pertinent whether there was a lock-out or lew or not.

Mr. Moffett said that he found certain re-organisation was necessary, and in consequence of that he served the notices dismissing the men. Eight were dismissed and 22 others were offered work of a different nature. The work complainants were doing was being done by foremen who were in their employment at the time.

Ultimately the Court unanimously decided that there was a lock-out, and fined the Corporation 10s. on each summons with 10 guineas cost.

United Kingdom Trade with Switzerland.—Mr. G. B. Beak, the acting British Consul General at Zurich, who is visiting this country, will be prepared to interview by appointment representatives of British firms at the offices of the department of Commercial Intelligence, commencing on the 22nd inst. Applications for interviews should be addressed to the Comptroller-General, Department of Commercial Intelligence, 73, Basinghall-street, London, E.C. 2, and the reference number, 46,273/17, should be quoted.

Women in Industry.—At last week's conference of the National Council of Women, Prof. Kirkaldy said that hitherto women had not aimed at taking a leading place in the various pursuits in which they were engaged. So long as they refused to accept the responsible positions, so long it would not pay the employer to give time and attention to training them and making them highly skilled [illegible] and mechanics.

Prof. Kirkaldy said that it could no longer be said that women were not physically capable of taking part in the hard work of the factory. [illegible] to the increased use of capital and the introduction of automatic machinery and machinery for lessening the burden of labour, the demand [illegible] on the operative was not so much for brute force as for intelligence. Women were now doing 30 per cent. of the Nation's work, against 25 per cent. before the war. He pointed out that conditions of industry [illegible] that women were not generally doing the [illegible] work formerly done by men, but that the invention of many ingenious machines had enabled them with little skill or training to [illegible] results. The [illegible] of the enormous output [illegible] "fool-proof machines"—that was to say, [illegible] which could be run after a short very term of instruction and [illegible] repetition work.

EDUCATIONAL.

Instruction in Technical Optics.—At the last meeting of the Governing Body of the Northampton Polytechnic Institute, Prof. Frederic J. Cheshire, director of the Department of Technical Optics in the Imperial College of Science and Technology, S. Kensington, S.W., was appointed honorary head of the Technical Optics Department of the Northampton Polytechnic in accordance with the [illegible] of the Board of Education and of the London County Council for the provision of instruction in technical optics. These [illegible] may now, therefore, be regarded as definitely and fully [illegible], and it is not too much to hope that, in view of the careful [illegible] given to their elaboration, their effect upon the training of present and future generations of optical workers will be an important factor in replacing the optical trade of this country in the leading position which it occupied until about the last quarter of the nineteenth century.

University of Sheffield. [illegible]

Coventry Municipal Technical Institute.—Mr. J. H. Belcher, the [illegible]

TENDERS INVITED AND ACCEPTED.

House Service and Fuse Boxes and Fittings.

[illegible]

Electric Omnibuses.

[illegible]

Electrical Fittings.

[illegible]

Railway Signalling Apparatus.

[illegible]

Tramcar Wheel Tyres, &c.

JOHANNESBURG.—[illegible] Oct. 17 for supply of 200 [illegible] tyres [illegible] or alternatively 200 steel pinion wheels (contract 302). Specifications from the Controller of Stores, Municipal Offices, Johannesburg.

MAIDSTONE.—The [illegible] & Co. for the installation of mechanical coal-handling plant at £1,543.

DERBY.—The Council has placed an order with C. A. Parsons & Co. for repairs to [illegible]

DUBLIN.—The [illegible] Haden & Sons [illegible]

MARYLEBONE (LONDON).—[illegible] Goodchild & Sons [illegible] £200.

STRETFORD.—The Urban [illegible] tenders:—

[illegible]

WOLVERHAMPTON.—The Council has accepted the following tenders:—

[illegible] feeder panels, £1,950; Stirling Boiler Co., boiler equipment [illegible] 5,000 kw. [illegible]

Transformer Contracts. Messrs. Ferranti, Ltd., have [illegible] received orders for the supply of transformers from the foll[owing]:—

[illegible]

APPOINTMENTS VACANT AND FILLED.

[illegible] Midlands [illegible]

[illegible] Palace-road, W. 6.

[illegible] engineer at Barnsley, during the absence at the [illegible]

[illegible] Works.

[illegible]

BUSINESS ITEMS.

[illegible]

BANKRUPTCIES AND LIQUIDATIONS.

[illegible]

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Bournemouth.—The tramway accounts for the year ended March 31 show gross capital outlay £477,585 (increase £408), of which £59,529 has been repaid. Redemption fund amounts to £47,994, renewals fund to £23,343, and reserve fund to £5,367.

Revenue was £114,321, and working expenses were £53,711, leaving gross profit £60,609, or £61,773 with net revenue additions. Interest required £10,720, sinking fund and loan repayment £17,225, rent of lines £7,737, allowances to dependents of employees on H.M. service £4,554, and income tax (schedule D) £4,157, leaving net profit £17,377 from tramways or £16,275 after deducting £1,102 loss on motor bus account. Average total revenue per car mile was 16·79d., and working expenses including power, were 7·88d. Passengers carried were 17,947,463, car miles run 1,634,640, and units used 1,048,123.

Bristol.—The electricity department's accounts for the year ended March 31 show that the amount borrowed for the undertaking is £931,062, and the capital expended £900,757, of which £413,495 has been repaid or provided for redemption.

Revenue was £143,923 (compared with £132,928 in previous year) and expenditure £98,348 (£75,291), leaving gross profit £45,574 (£57,636). Interest required £19,062 (£20,105), and £29,266 (£30,131) was provided for debt redemption, the net result being a deficit of £2,232 (against a profit of £7,911). Costs were 0·989d. (0·798d.) per unit exclusive and 1·475d. (1·349d.) inclusive of capital charges. Units generated were 30,103,957 and sold 23,579,139 (21,665,968). Maximum co-incidental load was 10,576 (9,874) k.v.a.

In his report Mr. H. Faraday Proctor (general manager) states that the 3,000 kw. turbo-generator referred to in his previous report, has been delivered, and is expected to be put in full running order during the present autumn. The load has increased so that further plant should be provided immediately. The Government restrictions practically prohibited supply to new consumers except for engineering and power purposes, the result being that there was a lessening of the normal increase for power purposes. Reduction in revenue, increases in cost of coal and other materials, and advances granted to employees, seriously affected the financial results, the increase in expenditure being £23,056 including £16,041 for coal. Load factor was 27·59 (26·5) per cent. Total connections are equal to 907,393 (859,924) 30-watt lamps, motors and heating apparatus connected aggregates 23,446 (21,664 H.P.

Salford.—The accounts of the tramways department for the year ended March 31, show gross capital expenditure £756,574, of which £402,587 is outstanding.

Income was £284,443 (compared with £275,920 in previous year), and gross profit was £80,217 (£92,868) and net profit £967 (£18,473), which has been placed to depreciation and renewals fund. Average total revenue per car mile was 12·033d., and working expenses, including power, were 7·933d. Average fares charged per mile were 0·46d. ordinary and 0·36d. by cheap morning cars. Passengers carried were 58,801,870 (56,458,266), car-miles run 5,673,639 (5,495,295), and units used 10,881,594 [illegible] per car mile.

Swansea.—The accounts of the electricity department for the year ended March 31 show gross capital expenditure £238,075 (increase £234,240), of which £179,917 is outstanding.

Revenue was £39,016 (compared with £38,295 in previous year), working and general expenses were £20,658 (£20,190), interest required £7,340 [illegible] and repayment of principal £6,600 (£5,496), leaving net profit £4,412 (£4,944). Average price obtained was 2·00d. (2·18d.) per unit [illegible] 1·18d. (1·37d.), and capital charges 0·8d. [illegible] demanded was 870 kw. [illegible] 440 kw. for [illegible] for other purposes. Units generated were [illegible] 4,499,570 [illegible] 4,198,226 (3,523,182).

[illegible] £119,650 [illegible] £22,811 [illegible]

[illegible]

Companies' Meetings and Reports.

COMPANIES' MEETINGS AND REPORTS.

MARCONI WIRELESS TELEGRAPH CO. OF CANADA (LTD.)—The report for the 11 months ended Dec. 31, states that notwithstanding the abnormal conditions and despite the various restrictions, an increased volume of Transatlantic traffic was handled between the Glace Bay station and Great Britain. The company's school of instruction has been a factor in contributing to maintain their staff in replacing operators assigned for duty in all parts of the globe. The output of the company's plant in Montreal was somewhat less than during the previous year, owing to a smaller number of installations being required for naval purposes. Advantage was taken of this opportunity to develop an improved type of ship apparatus. Compact and self-contained, the new cabinet set, either of medium or large size, can be installed on shipboard in short order. The new design has received favourable comment both in naval and mercantile quarters, and its success has been followed up by the development of a smaller set on similar lines. The company has been awarded further important orders for the purchase of a considerable number of wireless sets of various types. As a further step in the policy for increasing the facilities of the company's service to shipowners, a divisional office for the Maritime Provinces has been established at Halifax. The number of wireless telegraph stations operated by the company on shipboard has shown an increase during the year, notwithstanding the fact that several insallations had been lost or transferred to other routes. The directors regret that they have not yet been able to obtain from the Government a basis of settlement in respect of remuneration for the use of certain coast stations taken over by the Naval Department since the commencement of the war, or compensation for other services rendered to the Admiralty and elsewhere.

REES ROTURBO MFG. CO. (LTD.)—The accounts for the year ended Sept. 30, 1916, show, after providing reserve for taxation and £110,000 for depreciation reserve, a credit balance of £19,565 to be carried forward. The accounts are incomplete owing to the unascertained liabilities in respect of the munitions levy, excess profits and administration of the new munition works, for which provision has been made as far as possible.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

J. B. & J. ATHERTON (LTD.) (148,540).—Private company. Reg. Sept. 26, capital £1,000 in £1 shares. Manufacturers, merchants, importers and exporters of and contractors for fuel oil, ammonia, creosote salts, fuel of all kinds, mechanical and electrical engineers, &c. First directors are:—J. B. Atherton and J. Atherton.

F. A. JENNINGS (LTD.) (148,568).—Private company. Reg. Sept. 28, capital £3,000 in £1 shares, electrical, mechanical, motor and marine engineers, gunsmiths, &c. Mr. F. A. Jennings is permanent managing director. Reg. office: Reno Works, Rosslyn Crescent, Wealdstone.

MORTGAGES AND CHARGES.

BRITISH MINIATURE ELECTRIC VEHICLES (LTD.)—Issue on Sept. 14, 1917, of £1,000 debentures, part of series of which particulars have already been filed.

RURAL ELECTRICITY SUPPLY CO. (LTD.)—Particulars of £1,700 debentures created Aug. 10, 1917, have been filed, the whole amount being now issued. Property charged: Company's undertaking and property, present and future.

RECEIVERSHIP.

NORTH-EASTERN ELECTRIC SMELTING CO. (LTD.)—R. Temperley, Milburn House, Newcastle-on-Tyne, ceased to act as receiver or manager on Sept. 8, 1917.

CITY NOTES.

CUBA SUBMARINE TELEGRAPH CO. (LTD.)—An interim dividend for the six months to June 30, at rate of 5 per cent. per annum (tax free), has been declared on the ordinary shares.

DIRECT UNITED STATES CABLE CO. (LTD.)—The directors have declared an interim dividend of 2s. per share (less tax), making, with the interim dividend already paid, a total distribution of 4 per cent. for the half year to Sept. 30.

INDO EUROPEAN TELEGRAPH CO. (LTD.)—The directors have declared an interim dividend for the half year to June 30 at the rate of 5 per cent. per annum [illegible], payable on and after Nov. 1, subject to the terms of the Trading with the Enemy proclamations, to shareholders on the register on the [illegible] inst.

ROYCE (LTD.)—The net profit for the year 1916 was £7,464, and with £2,936 was brought forward. A dividend of 5 per cent. (tax free) is recommended on the ordinary shares, a sum of £5,000 has been written off goodwill, and £223 carried forward.

SUBMARINE CABLES' TRUST.—The coupon due on the 15th inst. will be paid by Messrs. Glyn, Mills & Co., 67, Lombard-street, E.C. 3.

THE ROUND TABLE.

By "KVA."

I have been crowded out with air raid items this week. I pass some of them on as an aftermath of the general upheaval. Brighton, for instance, I'm told, is now known among certain electrical men as "The Better 'Ole." Up to the present I have not had John Christie's sanction for the change of address.

* * * *

Another tragedy of the raid came through on the telewriter. It read as follows :—

Sorry to say light brindle bitch puppy has died from excitement.

* * * *

According to the daily press :—

Lord Rhondda has appointed Mr. H. B. Renwick to act as Director of Feeding Stuffs at the Ministry of Food, with the duty of organising the supply and distribution of oil cake and other cattle food. At the special request of Lord Rhondda, the County of London Electric Supply Co. (Ltd.), of which Mr. H. B. Renwick is managing director, has agreed to loan his services for the purpose of undertaking this work.

What a splendid example of [illegible] thinking. Mr. Renwick will see that the oil is electrically pumped, that the corn, &c., is electrically grown, and stored, and that the cows are electrically milked! Lord Rhondda, you're on our side after all!

* * * *

It's 20 years ago since I did any "shift work," but I must say the following appeals to me as an old engineer-in-charge :—

Petrograd, Oct. 1.

Telegrams from Kharkov state that the employés of the electric light company there arrested the directors and managers and shut them up in the board room. They then held a meeting, at which they rejected the proposal to apply summary justice to the directors and managers, but decided to keep them prisoners until they agreed to grant them higher wages.—Reuter.

[illegible] had to go into the chief's office, cap in hand, [illegible] "Sir!"

* * * *

ELECTRO-HARMONIC SOCIETY.

SEASON 1917-18. FIRST CONCERT.

Unofficial Programme.

In the Chair [illegible]

[illegible]

THIRTY-SEVEN YEARS AGO.

From THE ELECTRICIAN, October [illegible], 1880.

SALFORD.—The Salford Town Council [illegible] the policy of promoting a bill in Parliament [illegible] which, among other things, will [illegible] for powers to supply electric light.

JAMIN'S ELECTRIC LIGHT.—We understand that [illegible] have been given to proceed with the lighting up of the [illegible] Panorama, Leicester-square, and [illegible] Jamin's electric lights. The directors and artists of the Panorama have carried out some extensive trials at the works in Paris, and [illegible] satisfied that they [illegible] upon adopting this system.

ROYAL EXCHANGE RESTAURANT.—[illegible] grain of common sense and a [illegible] certain that some such [illegible] as he would [illegible] with [illegible] electric light [illegible] beneath the Royal Exchange. Fortunately, the [illegible] was discovered in time to prevent serious injury, although not in time to prevent considerable [illegible].

Electrically-Operated Fruit Pulping Plant.—Maidstone Corporation recently made arrangements to supply [illegible] for a large fruit pulping plant, [illegible] the pulping of [illegible] of plums. The fruit pulping [illegible] the large [illegible] works of Sharps [illegible] bays to the committee [illegible] of electrical supply is being [illegible] Sharps' works have [illegible] mains, and the motors already installed in this bay are sufficient to drive the pulping machines.

Street Supplies to Motor Vehicles.—Recently the Commissioner of Police suggested that the [illegible] for the supply to motor vehicles on the road of fuel, water and power [illegible] his attention and was likely to demand urgent attention after the war when motor traffic, especially the heavy variety, would increase in volume.

[illegible]

the proposal.

U.S.A. [illegible] Plant [illegible]

INDUSTRIAL HEATING IN CHICAGO.

The applications of electricity for industrial heating and domestic purposes is making rapid progress in the United States, but more particularly in the big cities and in the manufacturing areas. For instance, a census of electric heating devices connected to the mains of the Commonwealth Edison Co. (Chicago) showed that on July 1, 1916, there was a total of 33,270 devices with an aggregate rating of 23,857 kw. In 13 months ended Aug. 1 last, the number of devices in service had increased about 3,000 and the connected industrial heating load had increased 14,500 kw. The heavy increase in connected load as compared with the increase in number of devices is attributable to the addition of arc furnaces and such other large industrial applications. Among the smaller articles the commercial flatiron and the glue pots still retain the lead for popularity.

The "Electrical World" states that in more normal times this might be taken to indicate that the development period was past. But in these strenuous times it is perhaps more accurate to conclude that it signifies, if anything, that energies are all directed towards producing standardised goods and no time or effort can be spared for development. That the electric heating industry is going forward on all fronts is evident from the fact that in every case there are as many, and in 96 per cent. of the applications there are more devices in service now than there were a year ago.

In a table our contemporary gives a list of 50 different electricity-consuming devices, varying in number from commercial flatirons, of which 25,850 are in use, to tempering baths and monotype pots, of which only two each are recorded. Among the new applications to be recorded are four annealing furnaces (240 kw.) and six electrolytic furnaces (240 kw.); there was an increase in arc furnaces from four (2,680 kw.) to 13 (14,000 kw.), and there were also large additions to the number of glue pots, disk stoves, branding irons, soldering irons, heaters, air heaters, baking installations, &c. We think the table of sufficient interest to our readers to reproduce herewith:—

	1916		1917	
Device.	No.	Kw.	No.	Kw.
*Annealing furnaces	—	—	4	240
Air heaters (industrial)	40	46	156	161
Baking installations	10	127	13	142
Bacteriological ovens	7	6	14	13
Branding irons	80	28	192	75
Beer-vat dryers	11	33	12	36
Can cappers	105	36	124	49
Commercial flatirons	25,000	17,000	25,850	17,610
Coffee urns (commercial)	9	14	22	35
Disc stoves (industrial)	700	385	1,340	1,190
Drying ovens	7	18	38	101
Enamelling ovens	5	603	13	638
Embossing presses	11	17	12	18
Extract heaters	70	139	107	268
Furnaces (resistance)	18	38	32	126
Film dryers	13	27	13	27
Furnaces (arc)	4	2,680	13	14,000
Furnaces (electrolytic)*	—	—	6	240
Glue pots	5,000	1,150	6,200	1,380
Glue cookers	15	72	17	81
Glue-heating installations (special)	54	37	88	67
Immersion coils (liquid heating)	150	170	215	202
Ink dryers	160	96	235	141
Linotype pots	21	36	24	38
Liquid-heating installations (special)	65	72	82	94
Metal-melting pots	5	11	6	16
Material heaters	36	57	62	118
Monotype pots	2	4	2	4
Printing-press dryers	7	11	7	11
Putty-warming machines	5	9	7	12
Pleating machines	6	7	9	11
Photo print dryers	1	8	18	22
Pyrographic machines	5	29	5	29
Photo-chemical bath heaters	7	13	21	36
Popcorn machines	14	35	19	47
Roofing machine heaters	1	29	5	36
Radiant heaters (industrial)	240	144	356	202
Sealing wax heaters	200	40	278	59
Sterilisers	90	40	104	49
Soldering irons	750	150	920	192
Soldering iron furnaces	30	18	35	49
Solder pots	9	5	15	8
Tempering ovens	2	9	19	91
Tempering baths	1	7	2	14
Toasters (commercial type)	27	82	68	206
Vulcanisers (industrial)	18	14	35	26
Varnish heaters (process)	175	105	335	185
Wax knife heaters	34	9	43	12
Wax heaters	32	7	37	9
Waffle irons (commercial type)	12	12	23	23
	33,270	23,857	36,251	38,239

* New application.

THE CHEMICAL INDUSTRY AND THE WAR.

Prof. W. J. Pope, addressing a meeting of teachers at the Regent-street Polytechnic on Saturday, pointed out how Germany prepared for war by the establishment of a huge chemical industry which was built up around the coal tar industry and then by exporting a very large proportion of the world's requirements of coal tar colours and pharmaceutical and photographic products.

That success was achieved in spite of the fact that this country once possessed the whole of the heavy chemical industry of the world. We formerly produced practically all the nitric and sulphuric acids, and the greater part of the alkali used throughout the world. That had been taken from us by Germany's foresight and exploitation of scientific ability. Referring to the creation of the Department for Scientific and Industrial Research with an endowment of £1,000,000, Prof. Pope said the question we want answered was why that experiment was not made 20 years ago, at a time when it would have been undoubtedly successful in preventing the horrors of the last three years? We had suffered in the past from the exclusively British method of making the specialist entirely subservient to the administrator, the latter being generally chosen because he was available, because he was politically acceptable and because he knew nothing whatever about the subject which was to be administered and was therefore not likely to be prejudiced by any previous convictions. Even in 1915 the Government applied that same method to re-establish the coal-tar industry in this country. An organisation was established in which all the people in control were men who knew nothing whatever about chemistry or science, and naturally enough the Government organisation had proved not only a great failure, but had had the further effect of inhibiting the re-establishment of the coal-tar industry. That was to say, the organisation apparently was to do everything that was necessary, and consequently private effort was to a considerable extent hampered, and could not get on with the important problem of re-establishing that fine chemical industry. Such prevalent, but entirely mistaken, activity arose, he thought, from a lack of education. If it were generally demanded that no person should be regarded as decently educated who had not mastered the rudimentary principles of natural science and of scientific method, that farce, staged for the amusement of the whole world, in connection with the coal-tar colour question, would have been impossible.

Prof. Armstrong, who presided, declared that the present position of chemistry in this country was deplorable, owing to Government ignorance and indifference. The Board of Trade had, advisedly and of set purpose, put all scientific advice aside, and had taken measures which had not only proved a failure but which had actually retarded the development of the dyestuff industry.

POSITION OF GERMANY IN NORWEGIAN INDUSTRY.

The United States Consul at Stavanger recently reported to his Government as follows:—

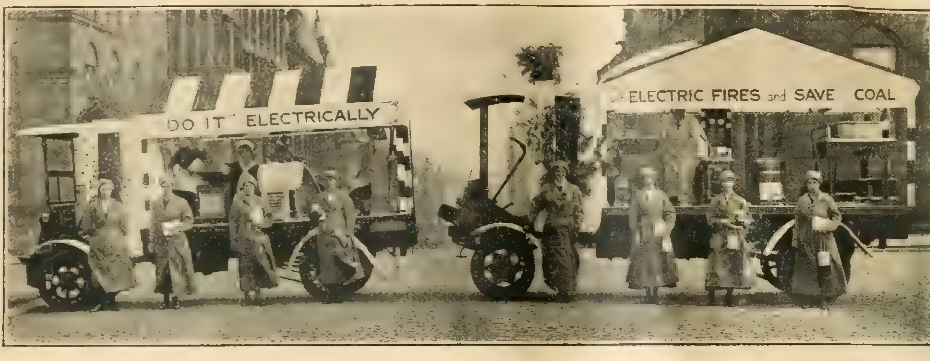
A good deal of American machinery and construction material has recently come into the district of Stavanger. This machinery is considered first-class, but it is doubtful whether the United States can hold the market in this line after the war unless special efforts are made by the individual American factories. The great increase of Norway's material wealth, the development of hydro-electric power from mountain lakes and falls, and the realisation of the necessity of being more economically independent by the use of natural resources, all increase the possibilities of Norway as a buyer of machinery and construction material. It seems likely, however, that as soon as the war is over the greater part of the orders will go to Germany. Among the reasons for the preference Norwegians have for dealing with Germany are the following: Norwegian engineers are practically all educated in Germany. They believe in the superiority of German methods and system, in the thoroughness of the instruction they have received, and the superiority of that country's text books. German measurements, calculations and catalogues are all more intelligible to them than others. Germany has for many years had an almost exclusive market for machinery and construction material in Norway. Norwegians are conservative, and prefer what they have tried to something new. The opinion prevails that Germany can supply goods more cheaply than other countries. In bids for construction material for public works, Germany is the first foreign country to be considered, then Sweden and the United Kingdom. Much German machinery, &c., is already installed, and when parts must be renewed they can most readily be obtained from Germany; parts made in other countries will usually not fit. For instance, a new patent electric stove ordered from America on trial could not be fitted to any electric socket because the sockets in Stavanger are made on the German plan. Travelling agents from Germany are nearly always on hand to make contracts personally or to aid in installations. They usually speak Norwegian, and take great pains to please possible customers.

PUBLICITY WORK IN GLASGOW.

It would appear that the Glasgow Corporation Electricity Department's showroom is contributing its quota to the special efforts for war funds, &c., and at the same time advertising its particular wares.

At the Women's Welfare Exhibition, recently held in Glasgow, for the purpose of spreading a knowledge of practical economy and domestic efficiency, cooking demonstrations were given daily by the showroom demonstrator, while the exhibition lasted, the apparatus used being a Carron range. Many enquiries were dealt with by the attendant staff and several sales were effected.

Our illustration shows two of the department's electric vehicles, specially decorated and loaded with electrical appliances, as a contribution to a Trades Procession and Pageant on behalf of a war fund. At the present time, when fuel problems are acute, the appeal of the coal and labour saving devices thus shown by the showroom staff is particularly strong. Such messages as "Use Electric Fires and Save Coal" were spread broadcast, and practical demonstrations of domestic operations by electrical apparatus were given by attendants in the vehicles. During the two years of the existence of Glasgow's electric showroom some 2,000 electric fires have been



installed in the Glasgow area; and vacuum cleaners, electric irons and other apparatus have been popularised and put into use to a similar extent. Recently some large electric canteen equipments have been fixed. The West of Scotland College of Domestic Science, whose premises are in Glasgow, has hitherto been content to confine itself to coal and gas ovens, but the College has now arranged to install a large electric cooker.

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

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CONTENTS.

NOTES.

The Spread of Electric Power.

We are interested to see a statement by Dr. J. F. CROWLEY to the effect that little advantage has so far been taken of electric power in the textile industry. It appears that only [illegible] per cent. of the power of textile factories in this country is obtained by electricity generated in the factories themselves and only ½ per cent. is taken from public undertakings. Figures of this kind enable one to appreciate the vast future there is before electric power. There is little doubt that in due time the electric drive will be used exclusively in textile factories. Moreover, the textile industry is not the only industry in which large [illegible] power will certainly take place. In fact, there are many where electric power at present plays no part but which, nevertheless, are likely to develop in the near future an electrical [illegible] marked extent. We do not think it is too much to say that within a comparatively short period electric power in [illegible] country will increase [illegible] [illegible]

The Position at Sheffield.

[illegible] power supply is found in a [illegible] public at Sheffield. [illegible] 1914 the [illegible] million units [illegible] sold during the current [illegible] [illegible]

[illegible] needs of manufacturers without hesitation. It [illegible] very low, being only [illegible] total cost, including capital charges. The average [illegible] margin on a large output. [illegible]

Engines for Submarines.

[illegible] petrol engines were used, [illegible] but nevertheless requ[illegible] 0·55 lb. to 0·63 lb. of fuel per hour; but [illegible] is interesting to note that [illegible] Reference is made to [illegible]

Effects of the War on Engineering Studies.

[illegible]

only 50 per cent. On the whole, it is anticipated that an immediate reduction in attendance of 10 to 25 per cent. will be experienced. The more advanced classes have suffered most severely, and the staffs in many cases have also been diminished. At present, therefore, the loss of students does not appear to have approached that prevailing in this and other countries where courses are often being run very largely for the benefit of neutrals. It must be expected, however, that the course of events will inevitably bring about a corresponding check on college work should the war be prolonged. That this general reduction in the number of engineering students is a serious matter for the whole world is admitted. It may be hoped that in the United States reasonable care will be exercised to ensure that men who have nearly completed their college course will be assigned duties in which their training will prove valuable; in this respect they will surely learn from the mistakes of other countries. The chief hope for the future is that the growing recognition of the benefits of scientific and engineering training will induce the authorities to do all in their power to get promising young men to enter the colleges after the war, and so make good in some measure the present wastage.

Institution of Civil Engineers.—Mr. W. B. Worthington, engineer-in-chief of the Midland Railway Co., has, from considerations of health, resigned the presidency of the Institution of Civil Engineers, to which he was elected at the last annual general meeting, and the Council has nominated Mr. Harry E. Jones, a vice-president, for the office of President for the year 1917-1918.

Society for Electrical Development (U.S.A.)—We observe that the Society for Electrical Development, in the United States, has issued the second part of its study on "Industrial Heating as a Central Station Load." Supplementary information relating to electric furnaces is given, and other varied applications of electricity are considered. The society has also issued a revised edition of its booklet entitled "More than 3,000 Uses for Electricity."

The "Trade Apprentice."—The September number of the "Trade Apprentice," the journal issued by the members of the Trade Apprentice School of the British Westinghouse Co., is a bright production, containing among other articles, a biographic sketch of Michael Faraday, by Mr. J. S. Brocklehurst. There are also notes on electrical switchgear and moulding methods, and lighter contributions referring to various sporting events organised by the staff.

Electric Ovens for the Army.—According to the "Electrical World," a firm in Chicago has submitted to the United States War Department an oven for electric cooking, intended for army use. The oven is designed to deal with the baking, boiling and frying operations necessary for about 150 men, and is stated to be the first oven to enable all these cooking operations [illegible]. The hot plate bracketed to the oven [illegible] the standard coffee receptacle used in the [illegible]. The oven is rated at 15 kw.

Standardising Lamp-Voltages in the United States.—In a recent Paper [illegible] American Illuminating Engineering Society [illegible] it is practicable to standardise the [illegible]

The "Faraday House Journal."—The issue of the "Faraday House Journal" for the Michaelmas term [illegible] (Vol. VII [illegible] Faraday House [illegible] important [illegible] glad to note that Lieut. J. N. Alty is now attached to the Army Ordnance Dept., and is stated to be doing very important work at the Front in France, for which his long experience at Faraday House qualifies him. The "Journal" also contains several technical articles dealing with "The Insulation Test of Electrical Machinery," "Iron and Aluminium Alloys," and "Radium Luminous Compound." There is also a short note on the Oerlikon Electrical Engineering Works in Switzerland, with which Faraday House is affiliated.

Zircon From Brazil.—According to the "Iron Age" Brazilian zircon is becoming a marketable product in the United States, being saleable at $50 to $60 per ton. Zircon is used chiefly in the manufacture of refractory crucibles and for the refractory linings of furnaces. Silicate of zirconia, the mineral known as zircon, is found in small crystals mixed with monazite in the sands, out of which the Brazilian monazite is washed. In the process of recovering monazite from these sands the zircon and the ilmenite (black oxide of titanium and iron) are separated. As the ilmenite has apparently no commercial value it is thrown away, but according to exporters, zircon can be marketed at $50 a ton with a small profit, in spite of high freight rates. With the present electric separating machines it is practically impossible to remove all the monazite from the zircon, and a residium of 2 per cent. to 6 per cent. of monazite, of small value and very difficult to recover, is bound to remain with the zircon.

Thermal Conductivity of Armatures.—In the modern armature one of the chief problems is to get as much output as possible within a given space of material without excessive heating. In a contribution by Mr. G. E. Luke to the "Electrical World," this question is considered in detail, and various methods of securing improved ventilation, promoting draught and providing paths of conduction for the heat are discussed. A point of some moment is the conductivity of the laminations of the armature, which was studied by getting temperature gradients illustrating the rate of flow towards the exterior. Results were secured on silicon steel, now widely used, especially in transformers, and on the high-grade soft steel commonly employed for armature work. In the former case the sheets are practically insulated with a film of oxide, in the latter with varnish. A striking feature of these experiments was the relatively high thermal coefficient of the ordinary soft steel lamination, more than twice that of silicon steel. However, the lower loss of energy in the silicon steel goes far towards compensating for this smaller heat-conductivity, and the choice between these materials involves a nice question of balance.

Speed Control and Stopping Devices.—The "Journal" of the Franklin Institute for September, summarising some notes from the Bureau of Standards, refers to the importance of speed-limiting devices for certain types of prime movers. More cases of rotating parts failing by over-speed occur than boiler explosions. In the case of steam turbines and belted water turbines such safeguards are particularly necessary, and even reciprocating engines are frequently fitted with extra valves and independent speed-limiting mechanisms. Water turbines in many cases are fitted with deflecting nozzles or vanes, usually operated by the governor, to prevent overspeed. Separately excited direct-current motors are particularly liable to run away, since their field excitation may be greatly reduced while the armature current is still maintained; and to a less degree series motors, motor generators in parallel or feeding storage batteries and rotary converters are also subject to runaway. Where directly connected to mechanical load dangerous overspeed is not likely to occur, but where belt connected or under a generator load which may be readily lost by the operation of automatic cut outs, the danger is much greater. Centrifugal devices, which at high speeds actuate trip devices for opening the source of energy supply, are most often utilised as a protection against such a contingency. Release coils, whether placed on starting rheostats or otherwise, in which the field current passes through the coil, are useful for preventing the undesirable consequences of a dangerously weakened field, and in some cases centrifugal speed limiting devices are added. Provision of more than one manual con-

[illegible] device is often [illegible] stopping prime movers or motors; through the use of relay control circuits a single valve or main switch can readily be operated from several points.

The Industrial League.—We have received a copy of a pamphlet which sets the aims and objects of this League.

The League is the [illegible] of [illegible] at a series of small meetings of employers and [illegible] labour leaders which have been held during the past two years. [illegible] is to bring employers and workers together in friendly relationship whereby they can arrive at a common understanding on [illegible] and industrial questions. The League seeks through personal [illegible] and discussion to secure co-operation between employers and workers, and the success which has been achieved in this direction at the London meetings of the League justifies the attempt to start local associations of the same character in the large centres of industry throughout the country. Such local associations would be affiliated to the parent body which would furnish them with assistance in organising meetings, provide speakers, literature and information on all subjects relating to trading, manufacturing, wages, housing, &c.

It is essential that direct contact be made with the workers, and through the medium of the trade unions and those members who are closely [illegible] League will adopt means by which [illegible]. The operations of the League will be controlled by a general committee composed of employers and labour representatives. The general committee is in process of completion, a number of prominent employers and labour representatives having signified their willingness to act. The complete list will be published shortly. The League will confine itself to an educative propaganda and will take no part in trade disputes. It will be, however, always ready to give such information as it may possess to all associations of employers and trade unions. It is the aim of the League to work in co-operation with all associations which have for their object the improvement of the relationship between employers and employed, and whenever possible and desir[illegible]

[illegible] one for individuals and another [illegible] subscription is £1 and firms and companies will pay £2 per annum. As the movement is a national [illegible] employers and workers. The hon. [illegible] 56 Victoria st., S.W. 1, and [illegible] M.P., and Lee Murray.

The Hydraulic Resources of France.—Reference has [illegible] in developing hydraulic [illegible]. In a recent issue of "La Nature" some [illegible] data on this subject [illegible] given, a comparison being [illegible] between the [illegible] water power of France and other countries. In 1914 it was estimated that there was available [illegible] H.P. for a minimum of 180 days in the year. This compares with the following estimates for other countries:—

	H.P.
[illegible]	[illegible]
[illegible]	6,750,000
Austria-Hungary	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

[illegible] in the Alpine regions of France [illegible] H.P. As yet, however, [illegible] water power is being actually used [illegible] though relatively [illegible]

The Production of Coloured Flames for Demonstration and Experimental Purposes.—[illegible]

[illegible] in length and [illegible] in diameter may be produced. The flame can then be coloured by the aid of a series of specially designed sprayers. [illegible] and allowing air to pass over the same to the burner. Two capillary tubes also pass into the vessel, [illegible] aluminium. The positive electrode is central and terminates slightly above the level of the liquid, while the negative passes down the side of the vessel [illegible]. The positive electrodes of all the sprayers are connected to one of the coatings of a Leyden jar and [illegible] that any of them in turn can be connected to the other coating of the jar. [illegible] sprayers, except the one to be used, are disconnected. A gentle current of air is then allowed to pass and coal gas admitted until a flame is obtained which is still luminous near the tip. Oxygen is then added until the flame is non-luminous. The flame is then coloured by passing sparks through the sprayer intended to be first used. Any of the other sprayers can be connected and used instead, in succession. In this way a flame coloured by any desired ingredient can be obtained. The flames thus produced are stated to be very useful for showing, in a large lecture theatre, the spectra of the more volatile elements such as Ca, Sr, K, Cu, &c.

OBITUARY.

[illegible] service are reported:—

[illegible] formerly in the service of the Oxford [illegible]

[illegible]

PERSONAL.

[illegible] G.C.M.G.

[illegible]

ARRANGEMENTS FOR THE WEEK.

FRIDAY, [illegible]

[illegible]

THURSDAY, [illegible]

[illegible]

A NEW ELECTRIC MINE HOIST AT BUTTE, MONTANA.*

BY R. S. SAGE.

Summary.—The Paper contains a description of the equipment in connection with a recent Ilgner-Ward Leonard hoist installation at the Elm Orlu Mining Co., Butte, Montana. This installation is one of the two largest of this type in operation in the United States. Complete data are given on two sets of tests: the first conducted to analyse a typical day's run and the second to determine efficiency while hoisting under known conditions.

GENERAL.

During the past year and a half great progress was made in the field of mine electrifications, particularly in the electrification of mine hoists of large capacity.

The number of Ward Leonard and Ilgner-Ward Leonard hoist equipments put into operation in the United States during 1916 and 1917 will equal the total number operating prior to 1916, and the aggregate horse-power capacity will be 50 per cent. greater.

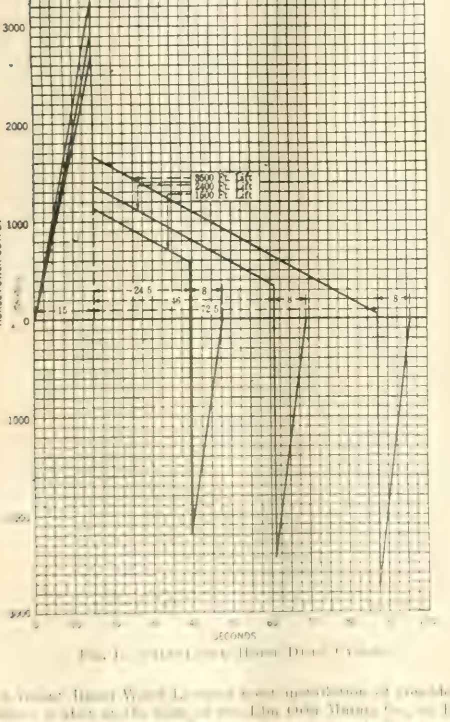

Fig. 1.—[illegible] Hoist Duty Cycles.

[illegible] Ilgner-Ward Leonard hoist installation of considerable [illegible] Elm Orlu Mining Co., at Butte, Montana. [illegible] in regular productive operation [illegible]

[illegible]

* [illegible]

DUTY.

The Ward-Leonard system, combined with a flywheel for load equalisation, commonly known as the Ilgner-Ward Leonard system, is widely used. In this instance flywheel equalisation was imperative, as the reservation charge is based on the maximum instantaneous demand. For this reason flywheel capacity was supplied sufficient to completely equalise the maximum duty cycle met in balanced hoisting from the deepest level.

The shaft has been sunk to a depth of 1,800 ft. (548·6 m.), and ore is being hoisted regularly from the 1,100-ft., 1,200-ft., 1,300-ft., 1,400-ft., 1,500-ft. and 1,800-ft. (335·2 m. to 548·6 m.) levels. Ultimately the ore will be taken from a seam 3,500 ft. (1,066·8 m.) below the surface.

The general characteristics of the hoist are as follows:—

Inclination of shaft with horizontal	90°
Present maximum lift	1,800 ft.
Ultimate maximum lift	3,500 ft.
Weight of skip and man cage	11,000 lb. (4,989 kg.)
Weight of ore per trip	10,000 lb. (4,535 kg.)
Weight of one rope (3,500 ft.)	12,500 lb. (5,669 kg.)
Maximum speed of skip during hoisting	2,500 ft. per min.
Diameter of cable	1·5 in. (38·1 mm.)
Weight of cable, per foot	3·55 lb. (1·58 kg.)
Drums—cylindrical—double-clutched.	
Diameter of drums	10 ft. (3 m.)
WR^2 of drums	3,600,000 lb. ft.^{2}
Maximum hourly tonnage (2,000 lb.) 3,500 ft. level	155
Assumed mechanical efficiency	85 per cent.

The calculated cycles of duty for the various levels, upon which the capacity of the electrical equipment was based, are shown in Fig. 1. To insure continuity of service, the most important consideration in installations of this kind, the first requisite is that the driving machinery have a safe margin of capacity. A heating guarantee of 40°C. rise for all parts of the electrical equipment was therefore made, for continuous operation, when hoisting the specified hourly tonnage from any level. The efficiency curves for the various machines are given in Fig. 2.

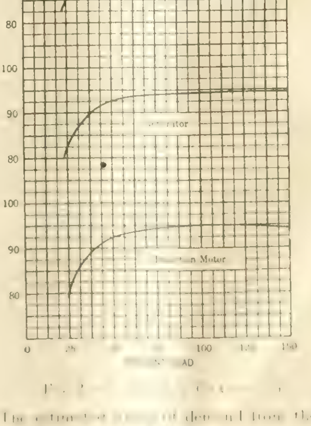

Fig. 2.—[illegible]

The [illegible] demand from the power supply for the various levels [illegible]:—

1,500 ft. level	[illegible] kw.
2,100 ft. level	[illegible] kw.
3,500 ft. level	[illegible] kw.

		75 [illegible]	50 per cent.	25 per [illegible]	Per cent. of max. hourly tonnage.
1,500 ft.	[illegible]	[illegible]	[illegible]	[illegible]	Hourly tonnage.
	[illegible]	[illegible]	2·83	3·57	Kw. hr. per ton.
2,100 ft.	[illegible]	[illegible]	101·0	[illegible]	Hourly tonnage.
	[illegible]	3·80	4·23	[illegible]	Kw. hr. per ton.
3,500 ft.	[illegible]	160	[illegible]	[illegible]	Hourly tonnage.
	[illegible]	[illegible]	6·17	7·45	Kw. hr. per ton.

The estimated overall efficiencies corresponding to the maximum hourly tonnages are as follows:

1,500 ft. level—overall efficiency	46·2 per cent.
2,400 ft. „ „ „	48·3 per cent.
3,500 ft. „ „ „	47·7 per cent.

The hoist is also used for practically all of the hoisting of an unproductive character, such as handling waste, men, timbers and supplies, and the hoisting of ore is done simultaneously with this sort of work.

The overall efficiency at which the ore is hoisted, that is, the ratio of the net work done in lifting a day's output of ore, to the kilowatt hours of electric energy used per day, is therefore much less than the figures given above. The mine is still in the development stage, so that the unproductive work is a large proportion of the total required of the hoist.

At the present time the slip regulator is adjusted so as to limit the demand to 400 kw., as this is sufficient for the present depths and the present manner of hoisting.

DESCRIPTION.

The hoist consists of two steel-plate drums 10 ft. in diameter, grooved to hold 1,900 ft. (579·1 m.) of 1·5 in. (38·1 mm.) steel cable per layer. The drums are mounted between three bearings on a single shaft which has an extreme length of 40 ft. (12·1 m.). Each drum is provided with an axial-plate-type clutch and a parallel-motion post brake. The diameter of the brake tread is 12 ft. (3·6m.).

The bearings are all of the two-part type provided with gravity feed lubrication, in addition to oil rings. Sight-feed oil gauges are provided for all the bearings.

To the drum shaft is coupled an 1,800-H.P., 80-revs. per min., 525-volt, direct-current motor, is supplied with two bearings and sole plates; the armature shaft is 14 in. (36 cm.) in diameter in bearing by 11 ft. 5 in. (3·4 m.) long, and has a forged half-coupling for connection to a corresponding half-coupling on the drum shaft. The armature is 9·5 ft. (2·8 m.) in diameter, while the outside diameter of the magnet frame is 14 ft. 5 in. (4·3 m.). The motor has 16 main field poles, the coils being wound for 125-volt excitation and has commutating poles to insure good commutation at the heavy overloads encountered in the service. The bearings in addition to being ring oiled, receive lubrication from the gravity feed oiling system. The extreme length of the hoist, with motor, is 51 ft. 9 in. (15·7 m.).

The motor receives its power through a set, consisting of a generator driven by an induction motor and a direct coupled flywheel and exciter.

The generator has a continuous capacity of 1,300 kw., at 525 volts, and in order to successfully commutate the heavy currents at the [illegible] it is equipped with commutating poles, and, in addition [illegible] winding is placed in the pole faces of each of the 12 main poles. As in the case of the hoist motor, the main field excitation is at 125 volts.

The induction motor [illegible] H.P., three phase, 60 cycles, 2,200 volts, and has a synchronous speed of 514 revs. per min. [illegible] of the wound rotor type [illegible] for connection to [illegible] slip regulator.

The flywheel is built up of [illegible] rolled steel plates, 11 ft. [illegible] in diameter, so that the [illegible] speed at synchronous [illegible] [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] an additional protection limit switches actuated by the skips themselves [illegible]

(a) Extreme direct-current overload.
(b) Overwind top or bottom.
(c) Loss of exciter voltage.
(d) Loss of motor-field excitation.
(e) Overspeed of hoist.
(f) Overspeed of motor-generator set.

The opening of [illegible] will not open the [illegible] brakes, but the operator is free to continue hoisting as long as the stored energy in the flywheel will permit. The opening of the line switch is indicated [illegible] When the direct [illegible]

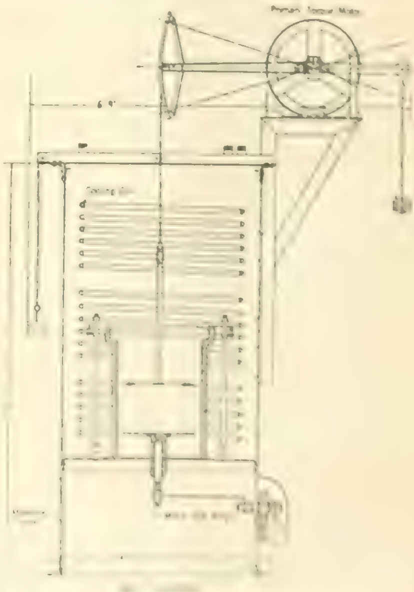

FIG. [illegible]

[illegible]

by the holding down bolts to hold it in place, the purpose of the tiles being merely to serve as barriers to prevent leakage between phases. Common sewer tiles are used for the purpose. The value of the input limit is adjusted in the usual manner by varying the number of the counter-balancing weights.

Tests.

The first set of tests was for the purpose of analysing a typical day's run under ordinary conditions, as regards its relation to the electrical equipment. In the second test, measurements were made of the electrical quantities for a few trips, to determine, if possible, the efficiency while hoisting under known conditions.

First Test.—A log was kept of all the movements of the hoist from 7 a.m. to 7 p.m., recording the time, the nature of all trips, quantity of ore, &c.

The hoist is used for the hoisting of ore, simultaneously with the unproductive work, as the conveying of timber, men and supplies. Moreover, the hoisting is of such an intermittent nature that a straight line input to the motor generator set is not even approximated, even at the low limit of 400 kw. Storage or bins are under construction, but were not in operation at the time of the tests. To illustrate the character of the load a portion of a typical day's load chart is shown in Fig. 4. This curve is reproduced from one of the daily records from the 30 in. per hour curve-drawing wattmeter included with the switchboard equipment. The results of this test are given below:—

Duration of test	12 hours.
Actual time hoist in motion	3·5 hours.
Total number of trips made	280
Number of skips of ore hoisted	63
Percentage ore trips of total	22·5 per cent.
Total weight of ore hoisted	252·5 tons
Average weight of ore per skip	4·01 tons
Average lift of ore	1,428 ft. (435·2 m.)
Net work done on ore-total	272 kw.-hr.
Net work done on ore per trip	4·32 kw.-hr.
Net work done on ore per ton	1·08 kw.-hr.
Kw.-hr. energy used during day	1,500 kw.-hr.
Total kw.-hr. energy used, including non-productive work per ton ore hoisted	5·94 kw.-hr.
Kw.-hr. used while hoist at rest	680 kw.-hr.
Kw.-hr. used while hoisting ore	582 kw.-hr.
Kw.-hr. returned to power system	14·6 kw.-hr.
Overall efficiency while hoisting ore	46·7 per cent.

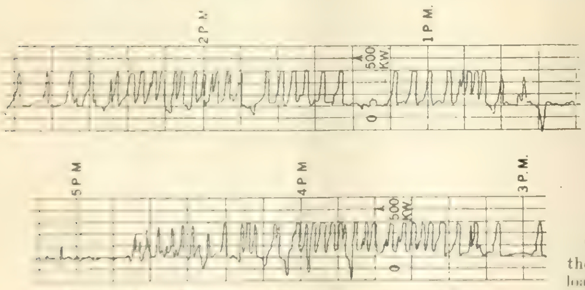

Fig. 4.—Load Diagram of Alternating Current Input.

The trips with ore were divided among the levels as follows:—

Level	No. trips	Vertical lift
[illegible]	6	1,068 ft. (325·6 m.)
[illegible]	3	1,100 ft.
[illegible]	3	1,271 ft.
[illegible]	20	1,325 ft.
[illegible]	7	1,475 ft.
[illegible]	22	1,535 ft.
[illegible]	2	[illegible]

[illegible]

Second Test.—[illegible] as possible [illegible] level 30 [illegible] the skips [illegible] loaded.

[illegible] the graphic meter of the direct current voltage [illegible] of the alternating current [illegible]. A [illegible] on all of the records [illegible]. The speed of the motor generator set was read at frequent intervals and tachograph [illegible] of the graphic records at the instant of [illegible] being kept which [illegible] the graphic record. The speed of the hoist motor was taken from the tachograph record and the 30in. per hour recording wattmeter supplied a record of the power delivered to the motor-generator set. The following conditions pertain to this test:—

Hoisting done in balance:

Duration of test	565 sec.
Lift	1,574·5 ft. (479·9 m.)
Number of skips hoisted	5
Weight of ore hoisted	20·3 tons
Average weight per skip	4·06 tons
Net work done—total	24·1 hr.
Average time per trip	113 sec.
Actual running time total	310 ,,
Actual running time, average per trip	62 ,,
Time at rest-total	255 ,,
Time at rest, average per trip	51 ,,
Average time for acceleration	22 ,,
Average time for running at full speed	15·5 sec.
Average time for retardation	24·5 ,,
Average rope speed	1,525 ft. per min.
Maximum rope speed	2,580 ,, ,,
Average speed of M-G. set	486 ,, ,,
Hoist motor input (exclusive shuntfield)	32·64 kw.-hr.
Hoist motor output	28·2 ,,
Mechanical efficiency of hoist	83 per cent.
Energy input to M-G. set total	50·5 kw.-hr.
Kw.-hr. per ton	2·49
Overall efficiency	4·77

The energy dissipated in the various parts of the equipment was found to be as given in the table below:—

	Kw.-hr.	Per cent. of net work.
Losses in mechanical parts of hoist, sheaves, guides, &c.	4·1	17·0
Hoist motor losses	6·25	25·9
Generator losses	5·53	22·9
Induction motor losses	3·99	16·6
Flywheel losses	4·08	17·0
Slip regulator losses	2·12	8·8
Exciter losses	0·39	1·6
Total losses	26·46	109·8
Net work done on ore	24·1	
Total energy consumed	50·56 kw.-hr.	
Overall efficiency	47·66 per cent.	

The hoist motor input was measured directly, and the output was obtained by deducting the losses which were based on factory test results.

The power input to the motor-generator set when running light as measured by the 30 in. per hour curve-drawing wattmeter and checked by the indicating wattmeter was 80 kw. at 512 revs. per min. For the average speed of the set during the test this was taken at 78 kw.

The segregation of the losses in the set was made from results of tests made in the factory. The running light input to the set includes:—

- Flywheel bearing friction and windage.
- Generator bearing friction and windage.
- Induction motor bearing friction and windage.
- Induction motor core loss and running light copper loss.
- Hoist motor shunt field (with economy resistance in series).
- Exciter loss with load of motor field.

The same total loss in the equipment is obtained by adding to the running light loss of the set, the increase in losses while under load, these being readily calculated. On this basis the result is as follows:

	kw.-hr.
Motor shunt field (increase)	0·248
Induction motor copper loss (increase)	0·223
Exciter loss (increase)	0·060
Generator losses (excl. friction and windage)	3·019
Motor losses (exclusive shunt field)	4·140
Regulator losses	2·120
Running light loss of set	12·250
Friction in mechanical part of hoist	4·1
Total	26·160

An item not included in the above segregation consisting of approximately [illegible] kw.-hr., used in operating the accumulator or pump and the [illegible] solenoids is also included in the running light input.

The total energy accounted for is therefore 50·81 kw.-hr., as against 50·5 shown by the wattmeter.

The energy output of the generator, as obtained from the direct current power [illegible] by the aid of a rolling planimeter, was 32·64 kw.-hr., and the input 38·17 kw.-hr. The input to the generator was at the rate of 243 kw., so that during the trips, approximately [illegible] kw.-hr. were required from the flywheel. The average speed reduction of the set during hoisting was 10·6 per cent.

on the basis of which the energy [illegible] during the five cycles was 96,500 kw.-sec., or 26·8 kw.-hr., which checks fairly well with the figure given above.

In general, the test results check very well with the estimated performance. The friction losses in the hoist, sheaves, rope and guides proved unexpectedly low.

The efficiency of hoisting exceeded that anticipated, even with the light loads, the load per skip being but 80 per cent. of that considered normal. With heavier loads, as when hoisting high grade copper ore, the efficiency would be further increased.

The tendency should be for the efficiency to increase at the greater depths, the maximum probably being reached at the intermediate levels.

[illegible] calculating the duty cycles and is the result of th[illegible] setting of the Welch safety device. At present there [illegible] policy of safety, require the slower rate [illegible] in the retardation period would further [illegible] efficiency of hoisting.

The stand-by losses are considered particularly low for an equipment of this capacity.

It is believed that by increasing the loading time so as to obtain a [illegible] period and bringing the load up to normal, the hoisting efficiency of this outfit will reach 50 per cent. at this level.

OPEN AND ENCLOSED TYPE FUSES.*

BY A. B. EASON.

Summary.—The author [illegible] the relative merits of open and [illegible] that have been published [illegible] their testing and standardisation. [illegible] on which the fusing of wires depends, and develops a formula relating [illegible] A table is given enabling this formula to be applied to practical cases.

This article deals with the question of fusing currents in open and enclosed fuses for carrying 3 to 100 amperes at 250 and 500 volts and carrying 60 to 1,000 amperes at 22 and 40 volts; such fuses are used in telephone exchange work.

The subject was investigated when standardising the "Fuses [illegible]" in use at the Post Office. Some notes on the subject [illegible] other reports may also prove of interest.

OPEN TYPE VERSUS ENCLOSED FUSES.

The open type fuse here considered is one in which the fuse wire [illegible] stretched between two terminals; along the greater portion of its length it is not in contact with any solid body. Small [illegible] some porcelain [illegible] fuses, and lamp fuses are often of this type.

The enclosed fuse is one in which the fuse wire is placed in a [illegible], the space between the tube and the wire being filled with [illegible] nature. If the fuse blows, a complete new enclosed fuse is inserted, and the blown fuse repaired at leisure after taking the case to pieces. The fuse wire is not visible [illegible] until the case is dismantled. [illegible] fuses and [illegible] fuses are of this type.

There are various types of semi-enclosed fuses which are intermediate between the open type [illegible] the enclosed type. The [illegible] is the porcelain bobbin type fuse with [illegible] the wire, with which the [illegible] in contact during [illegible] length. At the ends the wire [illegible] in the open [illegible] and is visible. The [illegible] of fusing currents [illegible] such semi-enclosed [illegible] types where the conditions [illegible] known, but it includes the [illegible] wire.

[illegible]

OPEN TYPE FUSES.

[illegible]

(h) Replacement of fuses is easy and costs little.

(j) The first cost is high if porcelain types of mountings are used, except when the porcelain handle acts as a switch and the cost of the switch is saved.

(k) The wire is subject to corrosion unless of suitable metal.

(l) The loss of heat from the wire is chiefly by radiation.

ENCLOSED FUSES.

(a) There is no danger of molten metal flying about.

(b) The filling keeps the metal relatively cool, so that the formation of an arc in vaporised metal is difficult.

(c) [illegible] made.

(d) The [illegible] the fuse; it depends chiefly upon the heat conductivity of the filling.

(e) [illegible] depends upon the lugs of the fuse. For instance, a 23 S.W.G. [illegible] carrier could be rated differently. The [illegible] area.

[illegible] absolutely reliable.

[illegible] wire.

[illegible]

* [illegible]

An attempt had been made to reduce the tolerance so that the variation in fusing current for a particular wire should only be

$$(1{\cdot}10 \sim 1{\cdot}15)I = i_0,$$

but manufacturers could not produce fuses which would fulfil this condition.

Lacount states that it is desirable to specify the minimum capacity of plant to be used to supply the current for the short-circuit testing of fuses, and also to specify the resistance of the circuit in series with the fuse. He made tests with fuses on alternating-current circuits, but the behaviour of the fuses was the same as when placed on similar direct-current circuits. It had been suggested that the eddy currents in the mountings would affect the behaviour of the fuses, but no such effect was found. In this connection it may be mentioned that open wire fuses under screw terminals on alternating-current circuits are liable to work loose on account of vibration. (*See* "Trans." A.I.E.E., 11/439/1894, and Andrew, "Electricity Control," p. 67.)

L. W. Downes ("Trans." Amer. Inst. Elec. Engr., 28/947/1909) deals with the design of enclosed fuses for currents of 50 amperes and upwards. He shows very clearly the desirability of making the fuse a multiple one; that is, to use five or ten strands or strips spaced apart from each other within the filling rather than having a single wire or strip of same sectional area placed at the centre of the filling.

When enclosed fuses are short-circuited the wire first heats then melts, then vaporises. If there is no cooling and the gas is fully vaporised, the volume of gas is about 2,400 times the volume of the metal. In order to obtain a cooling effect the surface of contact between the wire and the filling should be as great as possible; it is, therefore, better to use a number of strands or strips in parallel rather than one thick wire or strip. The heat in gram-calories transmitted from the wire to the outer casing is $k'(T_2-T_1)St/l'$, where

k' is the heat conductivity of the filling.
S is the surface of contact with the wire.
T_2 is the temperature of the wire; T_1 that of the casing.
l' is the mean length from the surface to the enclosure or case.

T_2 should be kept as low as possible for a given current i; therefore, l' must be as small as possible and S as big as possible; if T_2 is low there is less chance of an explosion. Downes gives very interesting oscillograph curves of voltages and currents existing during the blowing of fuses rated at 60–80 amperes. The fuses were short-circuited across a 6,000 ampere-hour battery fed by 500 kw. generators.

The common theoretical formula for fusing currents—viz., Preece's—which is mentioned in handbooks, manufacturers' catalogues, &c., is—

$$\text{Normal fusing current, } i_0 = \text{constant} \times D^{\frac{3}{2}}.$$

This current i_0 fuses the wire after a long time; its magnitude is determined either by (1) a slow current-temperature test, from the $i-T$ curve, or by (2) a quick fusing current-time test from the $i-t$ curve. In (1) the temperature T of the wire when traversed by various small currents is noted; in (2) the time t taken for the fuse to blow when traversed by various big currents is noted. The small and big currents have reference to the rating current of the wire in question. The first test is made by sending a current i through the wire until a steady temperature T is attained; now increase the current [illegible] and the temperature rises to $T+dT$; continue [illegible] allowing the temperature to become steady [illegible] after a certain number of increases the temperature will become T_4, the melting point temperature for [illegible]. The current which fuses the wire [illegible] the N.F.C. [illegible] sent through the wire when it was cold [illegible] before the fuse would blow. The [illegible] a current much greater than the N.F.C. through the wire, say, $5i_0$, which fuses the wire in t seconds; [illegible]

A current $5i_0$ [illegible] in 2 seconds.
A current $4i_0$ [illegible] in [illegible] seconds.
A current [illegible] in 30 seconds.
A current $2i_0$ [illegible] in 100 seconds.

If we plot a curve [illegible] t, the time for fusing, with the current, we find that the curve is hyperbolic, and that there is a point where [illegible] and the current is i_0. The current will be [illegible] found previously. [illegible]

A current [illegible] can carry the fuse [illegible] an infinite time.
A current [illegible] blows the fuse in 1,000 seconds.
A current [illegible] blows the fuse in 100 seconds.

All these [illegible] i_0.

[illegible] 1910, [illegible]

[illegible]

1. [illegible] constant $\times D$

2. The effect of holders on fusing current.

3. The ratio $\dfrac{\text{N.F.C. for single wire fuse}}{\text{N.F.C. for a stranded fuse}}$.

Tin fuses of 28, 24, 22, S.W.G., clamped to terminals 3 in. apart, were used; the fusing currents varied from 3 to 13 amperes; the rate of increase of current, di, was $=0{\cdot}1$ ampere. The variation of diameter in the wires was found to be less than 2 per cent., and was therefore neglected in the calculations.

In one case the chance air currents caused the N.F.C. to vary from 7 to 8·3 amperes for one wire. To avoid such variations special precautions were taken to prevent draughts. MacCall found that

$$\frac{\text{N.F.C. two-strand fuse}}{\text{N.F.C. one strand fuse}} = 1{\cdot}5 \sim 1{\cdot}73.$$

And that the value increased as the size of wire increased.

MacCall suggests that the fusing current might either depend upon T_4-T_1 if due to conduction, or upon $T_4^4-T_1^4$ if due to radiation, but does not associate the two expressions, as is necessary. T_4 is melting-point temperature; T_1 is air temperature.

Kefford ("Journ. I.E.E." 45/620/1910) discusses standardisation of fuses and gives the results of tests up to 60 amperes. He states that any specification for fuses should embrace—

(*a*) A definition of rating currents in terms of i_0.
(*b*) Ranges of rating currents and voltages.
(*c*) The definition of one or more points on the "time-overload" or $i-t$ curve (*see* equation 9 and 1).
(*d*) Regulations as to non-interchangeability, freedom from deterioration, temperature rise, perfect operation under all conditions.
(*e*) Specification for the carrying out of the overload and short circuit tests.

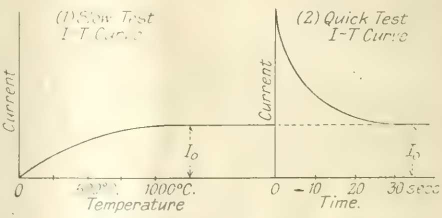

Fig. 1.

His discussion on the definition of rating currents is:—
Let rating current be I.
The fuse must blow in 4 hours when the current is $aI = i_0$.
The fuse must carry indefinitely a current $(a-a)I$.
In American practice $a = 1{\cdot}25$, $a = 1{\cdot}10$, so that

$$I = 1{\cdot}25 \, i_0 \, (1{\cdot}10) = 0{\cdot}80 \, i_0 \times 0{\cdot}91 \, i_0.$$

This allows a very small overload, viz., 25 per cent. of the rating value, so that a fuse rated at 10 amperes would blow eventually if 12·5 amperes were sent through it continuously. An overload of, say, 50 per cent., 15 amperes, would of course, blow the fuse relatively quickly, say, in 40 seconds. He suggests rating currents of 2, 4, 6, 8, 10, 15, 20, 30, 40, 50 amperes.

Kefford suggests that a fuse should blow in 1 minute when a current 1·50 I is sent through it. In the new Post Office specification we are asking that the fuse should blow within 5 seconds when a current 2 I is sent through it.

Theory of Fusing Wires.

Let:
Q = heat generated by the current per centimetre of wire per second.
[illegible] $i^2 r$ [illegible]
I = the rating current of the fuse; this may have any value up to about [illegible].
i = the [illegible] value of the current in amperes.
i_0 = the current [illegible] the wire in 4 hours or an infinite time.
i_5 = the current [illegible] the wire in five seconds.
i_∞ = The N.F.C. [illegible] wire of infinite length; that is, i_∞ is independent of l, the length of the wire.
[illegible] specific [illegible] of the metal per centimetre cube.
l = the length [illegible] wire between the terminals.
R = the radius of the wire in centimetres [illegible] D.
a = The temperature coefficient of electrical resistance per 1° C.
θ = the temperature of the wire in degrees centigrade.
t = the time in seconds.
T_1 = The absolute temperature of the air.
T_2 = the absolute temperature of the hottest point of the wire.
T_3 = the absolute temperature of the terminals.
T_4 = the absolute temperature at which the wire melts.

The units concerning heat quantities are :

q_1 = gram calories dissipated by conduction along the wire.
q_2 = gram calories dissipated by conduction to the filling.
q_3 = gram calories dissipated by radiation.
q_4 = gram calories dissipated by convection.
q_5 = gram calories dissipated in heating the wire.
k = conductivity of the wire in calories per square centimetre.
k' = conductivity of the filling calories per square centimetre.
m = density per cubic centimetre of the wire.
c = specific heat of the wire approximately for range T_1 to T_4.
l' = mean distance of the wire from the fibre tube enclosure.

The form of the $i-t$ curve in the quick test is to some extent hyperbolic because

$$\int \text{heating effect} = \int \text{heat emitted} + \int \text{heat given to wire}$$

$$i^2\int(s/\pi R^2)(1+a\theta)\,dt = \int A\,f(T)dt + \int(dq_5)dt.$$

The heat emitted before the wire fuses will be approximately $A't$ where $A'=Af(T)$, is some function of the radius of the wire and the temperature T_4. We assume that the rate of heat emitted by the wire at any temperature T only depends upon T, and that it is immaterial whether the wire is being heated up slowly or quickly. For instance, if the wire fused in 10 seconds the heat emitted or lost to the surroundings would be $10A'$, whereas if the wire were heated up and fused in 2 seconds the heat emitted would be $2A'$; this will not hold so well with enclosed fuses as with bare wires. $\int(dq_5)dt$ the heat given to the wire, will have to be sufficient to raise the

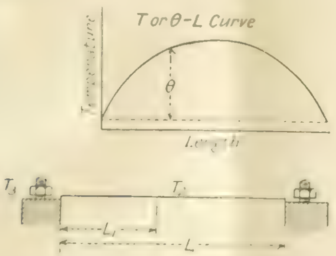

FIG. 2.

[illegible] to the fusing point temperature and this amount will be independent of the time taken, so that it will be a constant. [illegible] The heating effect of the current in the wire will be approximately [illegible] the rise of temperature [illegible] over the whole time [illegible] whether the heating is [illegible] quickly. We then get

[illegible]

[illegible] By putting [illegible] we get

[illegible]

[illegible] in the original Paper the nature of the [illegible]

If [illegible] through the wire the heat generated is dissipated thus:

(1) By conduction along the wire [illegible]

(2) By conduction to the filling [illegible] only with enclosed fuses.

(3) By convection [illegible] This is only appreciable with open fuses.

(4) By radiation. This is only appreciable with open fuses.

(5) [illegible] of heating [illegible]

[illegible]

The problem [illegible] lengths of [illegible] temperature of the hottest portion. For open type fuses [illegible]

[illegible]

[illegible] $=0$, the author eventually derives the following relation :—

$0{\cdot}23$ [illegible]

or [illegible]

Where [illegible]

It can easily be seen [illegible] put in the simple form [illegible] f_1, f_2, f_3 [illegible]

A series of [illegible] can be determined for various values of R.

The [illegible] constants of the wire. Apparently the convection loss has the chief effect in the case of small tin wires, as the heat lost by conduction is so small. The table gives particulars of wires from which f_1, f_2, f_3 may be found, when a value for c has been chosen.

For *enclosed* type fuses when the steady state is reached $Q=q_1+q_2$, and the terms for radiation and convection are not included, because whatever heat is dissipated from the fibre case must have reached there by conduction.

Schwartz and James [illegible] long Paper concerning [illegible] they recommend that for tinned copper fuses the rating current I_r should be [illegible] asks for [illegible] the fuse in an infinite time.

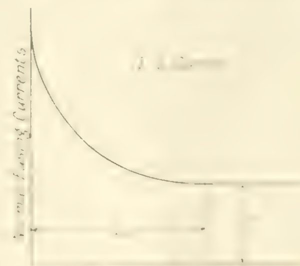

FIG. 3.

[illegible] true except for certain [illegible]

Table [illegible]

[illegible]

Formulæ of the form $i^2L=bd^n$ are given for fusing currents dependent upon the length of the fuse, but such formulæ are only very approximate. Obviously between the point where $L=0$ and f_1 is infinite, and where $L=$some value L_1 and f_1 becomes negligible and the length has no effect upon the fusing current, the form of the current length curve will be approximately:

$$i_0^2 = \text{constant } R^4\, L + i_0''^2.$$

Where i_0'' is the fusing current when L is infinity, Schwartz gives

$$i_0 = P i_0'' \; QR^2\, L.$$

Schwartz and James also give a table of constants for determining the fusing currents for bare wires of various lengths of various metals of various sizes from the formula $i_0=bD^n$, b and n being given in the table for the various units—inches, millimetres, or centimetres, in which d can be stated.

G. Roth ("Schweiz. Elecktrot. Verein. Bull." 7/193/1916, and "Science Abs. B." 19/364/1916) has stated that the current which will fuse silver wires within two minutes is :

$$\text{Amperes}^2 = 11{,}600R^{2\cdot 84} + 960{,}000R^4\, L^{1\cdot 3}.$$

NOTES ON THE DESIGN OF ELECTROMAGNETIC MACHINES.*

PART II.

DESIGN OF A SLOW-SPEED ALTERNATING-CURRENT GENERATOR.

BY STANLEY PARKER SMITH, D.SC.

(*Continued from page* 45.)

Summary.—In Part I of the article the author deals with some of the main principles underlying the design of alternating-current generators. In Part II these principles are applied to the design of a low-speed, three-phase alternator, giving 750 kw. at 2,200 volts when running at a speed of 250 revs. per min. In Part III a three-phase turbo-alternator is designed to give 2,000 kw. at 3,000 revs. per min. at a line pressure of 500 volts, and the mechanical stresses in the rotor are discussed.

(*c*) *Pole Leakage.*—This can be estimated graphically, as shown by Miles Walker in his book, or can be calculated for parallel or slightly divergent poles. To calculate the leakage flux between parallel poles we can split up the total leakage flux Φ_s into four component parts, as shown in Fig. 15. The ampere-turn AT_λ producing leakage flux are the ampere-turns or the gap, teeth and core, and it is seen that the maximum

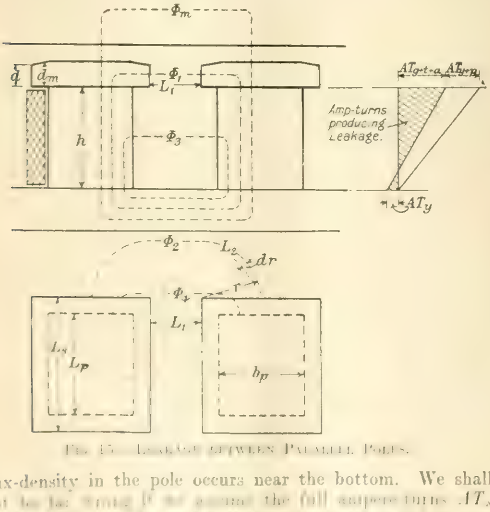

FIG. 15.—LEAKAGE BETWEEN PARALLEL POLES.

flux-density in the pole occurs near the bottom. We shall not be far wrong if we assume the full ampere-turns AT_λ produce Φ_1 and Φ_2 and half the ampere-turns $AT_\lambda/2$ produce Φ_3 and Φ_4. It will be noticed that the flank leakage lines are assumed to be straight lines [illegible] semicircles, [illegible] $L_1 = L_2$ [illegible].

We have then the leakage flux between the shoes

$$\Phi_a = 2\Phi_1 + 4\Phi_2$$

[illegible]

Leakage [illegible] flux between the poles is

$$\Phi_b = 2\Phi_3 + 4\Phi_4$$

[illegible]

Applying these to the present machine, we get

$$\Phi_a = 1{\cdot}25AT_\lambda\left(2\times\frac{32\times 1{\cdot}4}{8{\cdot}5}+2{\cdot}94\times 1{\cdot}7\log\left(1+\frac{\pi}{2}\,\frac{19}{8{\cdot}5}\right)\right)=17AT_\lambda$$

$$\Phi_b = 1{\cdot}25AT_\lambda\left(\frac{24{\cdot}5\times 16{\cdot}5}{9{\cdot}0}+1{\cdot}47\times 16{\cdot}5\log\left(1+\frac{\pi}{2}\,\frac{16{\cdot}0}{9{\cdot}0}\right)\right)$$

Thus we have : $=74AT_\lambda$.

Useful flux $=\Phi$.

Flux at top of pole $=\Phi+\Phi_a=\Phi+17AT_\lambda$.

Flux at bottom of pole $=\Phi+\Phi_a+\Phi_b=\Phi+91AT_\lambda$.

Flux in yoke = flux at bottom of pole.

It may be mentioned that in machines of this class the number by which AT_λ must be multiplied to get the leakage flux $\Phi_s=\Phi_a+\Phi_b$ seldom varies much from 100, and for most purposes we can assume $\Phi_a=20AT_\lambda$ and $\Phi_a+\Phi_b=100\,AT_\lambda$.

(*d*) *Magnetisation Curve.*—It is generally advisable in an alternator to know what part of the magnetisation curve is the working range, so that the calculation of the open-circuit characteristic (O. C.C.) really forms an essential part of the design of an alternating-current generator.

In most cases it is enough to calculate the requisite ampere-turns at 85, 100, 110 and 120 per cent. of the normal pressure. This is shown in the following Table. The areas of the different parts of the magnetic circuit were worked out in part (*b*) of this section, whilst the lengths are taken off the drawing. The length of the air-gap has been increased 10 per cent. to allow for chamfering the pole-shoes, and the mean value of the ampere-turns per cm. for the pole and teeth are found by aid of Simpson's rule. The curves used for finding the ampere-turns per cm. of the laminations are those given by Miles Walker on p. 42 of his book, whilst the curve for cast steel is No. 4 on p. 37.

The O.C.C. is shown plotted in Fig. 16.

(*e*) *The Exciting Ampere-turns on Load.* The vector diagram for full-load conditions has already been explained in Part I., and we shall adopt this simple approximate method in the present case rather than the more accurate method of splitting up the armature reaction into cross and direct components, as explained by Hawkins in "The Dynamo," and by other authors. The approximate method usually leads to more pessimistic results, which introduces a certain margin of safety and is good enough when regulation guarantees are not important.

The pressure diagram for full load at a power factor of 0·8 is shown in Fig. 17, from which we measure that the flux Φ' in the core on load (proportional to E') must be increased 3 per cent. and Φ in the air gap (proportional to E) 5 per cent., in order to maintain normal pressure at the machine terminals. The increase in the core is necessitated by the inductance of the overhang, and in the gap by the additional [illegible] effect of the armature ampere turns.

* [illegible] Miles Walker [illegible] XII., p. 2[illegible]

Calculation of Open-circuit Characteristic.

Induced E.M.F.: E_p. Useful flux: $\Phi\times10^{-6}$.			85 per cent. 1080 4·22.				100 per cent. 1270 4·96.				110 per cent. [illegible] 5·47.				120 per cent. 1525 [illegible]			
Part.	Area.	Length.	Φ	*B.*	at	*AT.*	Φ	*B.*	at	*AT.*	Φ	*B.*	at	*AT.*	Φ	*B.*	at	*AT.*
Core.	2×277	28	4·22	7,600	1·8	50	4·96	8,950	2·5	70	5·47	9,900	3·2	[illegible]	[illegible]	10,800	4·0	110
Teeth { min.	295	2×4	..	14,300	17	135	..	16,800	70	560	.	18,500	161	1,290	[illegible]	[illegible]	[illegible]	[illegible]
Teeth { max.	280		,,	15,100			,,	17,700			..	[illegible]			[illegible]	[illegible]		
Gap	578	2×0·55	..	7,300		6.430	..	8,600		7,570	..	9.450		8.320	..	10,300		9.070
AT_t						6,615				8,200				9,700				12,000
Poles { min.	360	2×16	4·33	12,000	15	485	5·10	14,200	30	960	5·64	15,700	[illegible]	[illegible]	6·17	[illegible]	142	[illegible]
Poles { max.			4·82	13,400			5·71	15,900			6·35	[illegible]			[illegible]	[illegible]		
Yoke	2×232	20	..	10,400	9	180	..	12.300	13	260	..	13.700	[illegible]	[illegible]	..	[illegible]	[illegible]	[illegible]
ΣAT						7,280				9,420				12.030				[illegible]
$I_f=\Sigma AT/134$						54·3				70·3				[illegible]				128·3

The reaction of the armature-turns on the field ampere-turns is shown in the vector diagram in Fig. 17, where AT_a is added vectorially to $AT_{core}+AT_{teeth}+AT_{gap}$ giving AT_p.

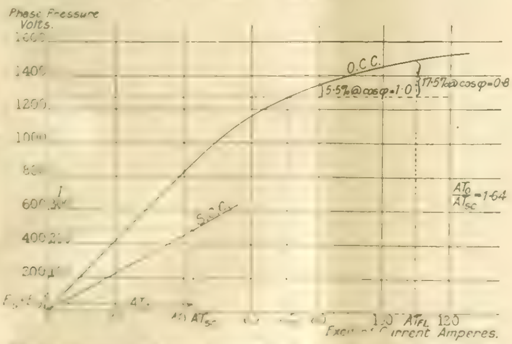

FIG. 16.—OPEN- AND SHORT-CIRCUIT CHARACTERISTICS OF SLOW-SPEED ALTERNATOR IN FIG. 13.

The magnitude of the armature ampere-turns AT_a is calculated from equation 7A as follows:

$$AT_a=kqdI_p=2\cdot13\times9\cdot75\times246=5,100.$$

The calculation of the ampere-turns on load is carried out below:

Excitation at full load and [illegible] power-factor.

[illegible] V=1,270 volts.

Part.	Area.	Length.	Φ	*B.*	at	*AT.*
Core	2×277	28	[illegible]	9,200	2·6	70
Teeth { [illegible]	295	2×4	[illegible]	17,300	101	810
Teeth { [illegible]	280		[illegible]	18,600		
Air gap	578	2×0·55	[illegible]	9,000		7,920
			AT [illegible]			8,800
			AT [illegible]			12,[illegible]
Poles { [illegible]	[illegible]	[illegible]	[illegible]	15,100	[illegible]	1,8[illegible]
Poles { [illegible]			[illegible]	17,[illegible]		
Yoke	[illegible]	20	[illegible]	13,700	20	[illegible]
			ΣAT [illegible]			[illegible]
			$I_f=\Sigma AT/134$			[illegible]

[illegible] namely:

[illegible] watts per kg.

[illegible]

Volume of teeth [illegible] $\frac{[illegible]}{2}$ [illegible]

Weight of teeth [illegible] 301 kg.

[illegible] kw.

(ii.) *Iron loss in the Core.*

Volume of core $=\pi h(D_c - h)l_c = \pi\,11\,(240-11)\,25\cdot2$ [illegible]

Weight of core $=200,000\times7\cdot8\times10^{-3}=1,560$ kg.

The core loss at full load is then found to be 12·5 kw.

The total iron loss at full load is thus 8·5+12·5=21 kw.

Though this loss may appear high—it is nearly 3 per cent. of the output—it is [illegible] puting the losses, owing to the additional stray losses, &c., which occur on load and which are generally ignored when calculating the losses separately.

(*g*) *Regulation.*—The voltage rise is read off the magnetisation curve by inserting the full-load exciting current. In this way the following values are obtained for the regulation:—

Voltage rise from full load at cos φ=1·0 to no-load, 5·5 per cent.

.. .. .. 0·8 17·5 per cent.

(*h*) *Short-circuit Characteristic.*—This is shown in Fig. 16. The stator current is set off to a suitable scale along the

FIG. 17.—[illegible]

[illegible]

that the distance between the pole and the inside of the rotor winding is 5 mm., while the depth of the winding space is 155 mm.

Taking a strip 22 mm. wide, the length of a mean turn $l=\pi(17+2\cdot2)+2\times10=80$ cm. The required section of copper is then

$$a=\frac{l\rho AT}{5{,}000V_e}=\frac{80\times12\times15{,}500}{5{,}000\times70}=42\cdot5 \text{ mm.}^2,$$

where we take $V_e=0\cdot7V=70$ volts, and the exciting pressure $V=100$ volts.

If, then, we use a strip 22×2 mm.$=44$ mm.^{2} and allow a 0·2 mm. strip of presspahn between turns and about 5 per cent. for slack, we shall get $0\cdot95\times155/2\cdot2=67$ turns per spool.

The exciting current will then be

$$I_e=\frac{15{,}500}{2\times67}=116 \text{ amperes},$$

giving a current density $\sigma=116/44=2\cdot64$ amperes per mm.^{2}.

The total length of copper in the exciting winding is then

$$l_t=24\times67\times80=128{,}500 \text{ cm.}=1{,}285 \text{ m.},$$

hence the weight of copper on the rotor is

$$W=8\cdot9\times0\cdot44\times128{,}500\times10^{-3}=505 \text{ kg.}$$

The resistance of the exciting winding is

$$R=0\cdot0204\times1{,}285/44=0\cdot6 \text{ ohm at } 60^\circ\text{C.},$$

so that the exciting pressure

$$V_e=RI=0\cdot6\times116=70 \text{ volts (70 per cent.)}.$$

and the rotor copper loss is

$$I_eV_e=116\times70=8{,}100 \text{ watts.}$$

To check whether this loss can be dissipated without exceeding the guaranteed temperature rise, we can use the simple rule given by Miles Walker on p. 232 of his book, where he allows about 0·17 watt per cm.^{2} for a rise of 40°C. with bare copper strip on a pole where the length is equal to the pole-pitch and the peripheral speed is 25 m. per second.

The cooling surface of a bobbin (inside + outside) is

$$15\cdot5\{(\pi17+2\times10)+(\pi21\cdot4+2\times10)\}=2{,}500 \text{ cm.}^2.$$

Hence the loss per cm.^{2} is equal to $8{,}100/(24\times2{,}500)=0\cdot135$ watt, which is within Miles Walker's figure, so that we have a good margin on the permissible 50°C. On the other hand, it is not advisable to push this figure right up to the limit, unless special considerations compel us to do so, for a high efficiency always pays for itself.

5. Efficiency.

Efficiency at cos φ = 1·0.

Load.	5/4.	4/4.	3/4.	2/4.	1/4.
Iron loss ...	20,400	20,000	19,700	19,400	19,200
Copper loss, stator	13,000	8,000	4,300	1,800	400
„ „ rotor	3,900	3,500	3,200	3,000	2,800
Windage and friction	8,000	8,000	8,000	8,000	8,000
Total losses	45,300	39,500	35,200	32,200	30,400
Output	937,500	750,000	562,500	375,000	187,500
Input.........................	982,800	789,500	597,700	407,200	217,900
Efficiency in per cent.	[illegible]	95·0	94·2	92·2	86·1

Efficiency at cos φ = 0·8.

Load.	5/4.	4/4.	3/4.	2/4.	1/4.
Iron loss ...	[illegible]	21,000	[illegible]	20,200	20,000
Copper loss, stator	[illegible]	13,000	7,100	2,900	700
„ „ rotor	[illegible]	7,200	[illegible]	[illegible]	3,000
Windage and friction ...	8,000	8,000	8,000	8,000	8,000
Total losses	[illegible]	[illegible]	[illegible]	[illegible]	31,700
Output	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Input	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Efficiency in per cent.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible] an accurate calculation [illegible] a [illegible] can be made [illegible] sufficient for most practical purposes. The iron losses do not vary much with the load; the stator copper loss varies as the square of the current, except for the effects of temperature and eddy-currents; the rotor loss can be estimated when the exciting current is known for the different load conditions; the mechanical losses can be taken as about 1 per cent. of the output in this machine.

Schedule of Leading Particulars of Design.

Slow-speed Alternating-current Generator.

Number of phases	3
Output	750 kw. at cos φ = 0·8.
Line pressure	2,200 volts with phases joined in star.
Current	246 amp. per phase.
Speed	250 revs. per min.
Frequency	50 cycles per sec.
Temperature rises to be in accordance with E.S.C. Rules.	
Main Dimensions.	
Number of poles, $2p$	24
Armature diameter, D	210 cm.
„ periphery	660 „
Pole-pitch, Y	27·5 cm.
Air-gap, l_g	0·5 cm. at centre.
Total core-length, L	32 cm.
Vent ducts	4 of 1 cm. each.
Net core-length	25·2 cm.
Thickness of plates	0·5 mm.
Peripheral speed of armature, v	27·4 metres per sec.
Output coefficient, C	15·9
Yoke.	
Cast steel	8×29 cm.
Poles.	
Cast steel, oval-shaped, cast with yoke	26×10 cm.
Shoes: arc, length	19×32 cm., laminated.
Stator Slots.	
Number of slots, S	117
Slot-pitch, y	5·64 cm.
Size of slot	40×25 mm. with 5 mm. opening.
Stator Winding.	
Type: symmetrical 3 phase wave winding.	
Number of similar parts, a	3, joined in series.
Number of slots per pole and phase, q	1·625
Number of coil-sides per slot, u	6
Number of coils, C	351
Number of turns per coil, T_c	1
Number of turns per phase, T	117
Coil-span (back winding pitch), y_b	31 coil-sides.
Connecting-pitch (front winding pitch), y_f	27 „
Slot insulation	1·25 mm.
Conductor, section A	60 mm.^{2}
„ made of strip	6×10 mm.
„ insulation—tape and interleaved mica.	
Current per conductor, I_a	246 amperes.
Current density	4·1 amperes per mm.^{2}
Length of conductor	78 cm.
Resistance per phase	0·053 ohm at 15°C.
Effective resistance per phase	0·058 ohm at 15°C.
„ „ „ „	0·071 ohm at 70°C.
Resistance drop at full load	1·38 per cent.
Reactance „ „	8·0 per cent.
Rotor Winding.	
Type	strip on edge.
Length of mean turn	80 cm.
Conductor, section a	44 mm.^{2}
„ made of strip	22×2 mm.
Number of layers	1
Turns per layer	67
Turns per pole	67
Insulation between turns	0·2 mm. ppn.
Exciting current at full load	111 amperes.
Current density	2·5 amperes per mm.
Resistance of exciting winding	0·6 ohm at 60°C.
Specific Loadings.	
Specific electric loading, ac	262
Specific magnetic loading, B_{max}	5,640

(To be continued.)

BOOKS RECEIVED.

[Copies of the above-mentioned works can be had from The Electrician Offices, on receipt of published price, plus postage.]

"Theory and Calculation of Electrical Apparatus," by C. P. Steinmetz, A.M., Ph.D. (London: Hill Publishing Co., Ltd.) Pp. xxii.+480. 17s.

"Electrical Measurements," by F. A. Laws, S.B. (London: Hill Publishing Co.) Pp. xii.+719. 21s. net.

"Principles and Practice of Electrical Engineering," by A. Gray, M.Sc. (London: Hill Publishing Co.) 2nd edition. Pp. xvi.+431. 12s. 6d. net.

HIGH-POTENTIAL BATTERIES FOR SUPPLYING SMALL CURRENTS.*

BY FRANK HORTON, SC.D.

The difficulties attending the use of a high-potential battery capable of supplying a current of a few milliamperes are familiar to all who have experimented with the discharge of electricity through gases. The type of battery most commonly employed for this purpose consists of a number of small secondary cells with lead plates. The chief trouble is the "rotting" of the lead of the positive plate at the point where it passes through the cover of the cell. The rotting consists in the formation of a white powder which analysis shows to consist mainly of lead sulphate; in a few months, or even weeks, the rod may thus be separated into two pieces. The rapidity of this action depends on the quality of the lead used.

This type of small storage-cell was originally provided with an indiarubber cover, but the contact of the rubber and the lead was found to be the cause of rotting which occurs. The lead rods of the electrodes were therefore covered with short glass tubes to prevent this contact; this device generally lengthens considerably the life of the cell. More recently wooden tops well soaked with paraffin-wax have been substituted for the rubber and glass tubes; but these appear to be quite as bad as the old indiarubber ones. [illegible] 20 per cent. of the positives of [illegible] new battery of 320 such cells recently rotted through in the course of three months. The remaining positives, and the new ones replacing those spoilt were [illegible] they pass through the wooden covers; but though as usual, this increased the length of [illegible] broken positives [illegible] never reliable.

The rotting of the positive plate is due to electric conduction [illegible] sulphuric acid. In [illegible] tightly round the lead [illegible] the rods from both plates [illegible] The rotting may be prevented [illegible] but some other [illegible] needed to keep the plates in position and prevent the splashing of [illegible] It would be convenient to [illegible] to keep the plates vertical [illegible] at the present time. In a long [illegible] can be made to keep the plates in position, but a safer device is to cut a strip of thin celluloid of width equal to the distance apart of the plates and to bend this into a ∩ and place it between the [illegible] of the cell. The top of the celluloid separator should be below the level of the acid in the cell and a small hole should be made in the top of it to allow the gases to escape when the cell is being charged. The splashing of the acid [illegible] prevented in the [illegible] covering the surface with a [illegible] A battery of [illegible] cells arranged in the way [illegible] for several months.

The advantage of a battery which does not require periodical charging [illegible] Several types of primary cell have been used [illegible] work and for experiments where potential [illegible] very minute current is required. They are often troublesome to fit up, but require no further attention [illegible] The currents of the order of [illegible] made by the British Ever-Ready Co. very convenient for this purpose. [illegible] milliampere [illegible] taken from the battery.

[illegible]

insulated [illegible]

[illegible]

[illegible] by turning a handle in the centre, the difference of potential between the two terminals can be increased by [illegible] from 0 to 33 volts. A convenient feature of the battery-box is the ease with which the cells can be removed and replaced by new ones. The cells are cylindrical in shape, the outside being of zinc which is the negative pole of the cell. [illegible] connected to the positive pole protrudes from the centre of the top of the cell. The cells are each about [illegible] arranged in [illegible] sheets of ebonite, one of which forms the top of the box and the other is inside the box and is supported from the top by four ebonite rods. Each cell is held in position by two copper springs.

Inside the box a radial arm makes a rubbing contact with the brass clips pressing on the central projecting positive poles, and the position of the arm is indicated by the pointer which moves over the dial on the top of the box. This arm is connected to a left hand terminal; the other terminal is conn[illegible] first cell in the series. It has been found con[illegible] have one position of the pointer in which there is no [illegible] between the terminals ("off"). This forms a simple [illegible] breaking the battery circuit. It is also convenient for so[illegible] to have a position in which the terminals are conn[illegible] difference of potential between them ("0"). T[illegible] ("1") puts in the first cell, and thereafter t[illegible] between the terminals rises by appro[illegible] 1·4 volts as the handle is rotated, unt[illegible] the circuit.

[illegible] in diameter and 20 of these [illegible] as having a longer life than the small [illegible]

* [illegible] Magazine."

SCIENCE AND TEXTILE INDUSTRY DEVELOPMENT.

[illegible] Industries."

[illegible]

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FUEL RESEARCH.

The second Report of the Fuel Research Board has just been issued, and will be found in abstract on another page. It is evident from this Report that substantial progress is being made in evolving a comprehensive scheme of research on fuel. The field is so large and of such national importance that it requires unusual steps to obtain the information necessary for answering the many questions which arise. Engineers are familiar enough with high temperature carbonisation, and there is no question as to the results obtainable with temperatures ranging from 900°C. to 1,200°C.; but it is rather from the point of view of low temperature carbonisation that the problems must now be considered. In this direction investigations have been carried on for some years, but they have either been of a spasmodic character or by syndicates attempting to work commercial processes, with the result that there is very little authoritative information available. Many claims have been made, and, while some of these may be true, the fact remains that there is a great deal still to be done in devising special forms of apparatus for the economical carbonisation of coal at low temperatures and in filling up the gaps with further information. It is only after plant of this kind has been evolved on a commercial scale, and after trustworthy tests have been carried out over a considerable period, that the economic possibilities of low temperature carbonisation can be fully weighed.

It is pointed out in the Report by the Director, Sir GEORGE BEILBY, that there are many fundamental problems which the Board must consider. For example, how much of the 35 to 40 million tons of raw coal now used for domestic heating can be replaced by low temperature coke? Can sufficient supplies of oil for the Navy be obtained by low temperature carbonisation? Can electric power be obtained more cheaply if the coal at present used in steam raising is first subjected to carbonisation and gasification? Can our peat deposits be economically used? Can the use of gas fuel in industrial operations be extended by the development of more scientific methods of combustion?

Such questions as these can only be answered by systematic investigation. With its unusual facilities, the Board will be in a position to add very materially to our knowledge, more particularly if it works in sympathy with individual investigators. We are glad to note the expression of opinion that it would be a great misfortune if the establishment of a Government organisation for fuel research were to result in the discouragement or limitation in any way of the activities of outside workers or organisations. It should be the function of the Board to assist and to investigate rather than to design. From this point of view the proposed research station should be of the greatest utility.

There is an important point raised in the Report as to the commercial realisation of low temperature carbonisation on a large scale. No scheme of this kind can go forward satisfactorily unless there is an assured market for the products. It has often been necessary for an industry to create a new market. For example, the shale industry. It may similarly be necessary for low temperature carbonisation to create its own market. Nevertheless, there are certain outlets already available, and it may be that these will prove sufficient—at least for a start. For example, the oil requirements of the Navy are large, and provided the oil obtained from coal were of the required character, and could be supplied at a competitive price, a ready outlet would be thus available. At the same time, it is well to realise that one million tons of fuel oil for the Navy would probably liberate 15 million tons of coke, and it would be necessary to dispose of this for domestic or other requirements. Owing to the disposal of this coke being a vital question, the proposed research scheme is to include a complete inquiry into (1) the use and value of coke for direct firing of steam boilers, (2) the gasification of the coke in recovery producers, and (3) the use of such coke for industrial and domestic heating. It is thought that the second of these problems will involve the development of a special form of gas producer.

From the point of view of the electrical industry, the most important question is the possibility of producing considerably cheaper power by means of low temperature carbonisation and gasification processes. Here the problem is complicated by all the questions involved in the various stages which are to be considered by the Research Board, both technical and commercial. As the Report points out, no answer can be accepted which is not founded on the complete working out of a scheme, no important step in the series of operations being omitted or slurred over. According to the report, the Board realise that possibly the net result of inquiry into this question will show that the use of carbonisation methods has not much to commend it, but that certain incidental advantages would justify its use in particular cases. This is a cautious statement, and, perhaps, at the moment we cannot expect a show of greater confidence. Be this as it may, the sum total of our knowledge is sufficiently stimulating, and we may hope that, in the final result, low temperature carbonisation will show itself to be a means of obtaining the cheap power that is so important in this country.

REVIEWS.

Atoms. By JEAN PERRIN. Translation by D. LL. HAMMICK. (London: Constable & Co.) Pp. xiv. + 211. 6s. net.

Cordial thanks are due to the translator for his presentment of Perrin's famous work on "Les Atomes."

If the reviewer may venture to give a broad but imperfect summary of the book, he may say that it deals principally with discontinuities. The reader is first introduced to ordinary examples of discontinuity; he is then introduced to the discontinuities of matter, as exemplified in atoms; and ultimately he is made acquainted with a great variety of discontinuities.

The preface of 10 pages is brilliant, suggestive, and ingenious, and the conclusion seems irresistible "that an infinitely discontinuous ether, studded with minute stars, is the picture presented by the universe if we remember, with J. H. Rosny, senr., that no formula, however comprehensive, can embrace diversity that has no limits, and that all formulæ lose their significance when we make any considerable departure from the conditions under which we acquire our knowledge."

Chapters I and II deal with Chemistry and the Atomic Theory, and with Molecular Movements. In these chapters Perrin throws fresh light on old subjects, such as Avogadro's Hypothesis, Dulong & Petit's Law of Specific Heats, Prout's Hypothesis, Mitscherlich's Law, Valency, Stereochemistry, Constitutional Formulæ, Laws of Solution, Ions, Molecular Velocities, Equipartition of Energy, Specific Heats of Gases and Solids, the Molecular Diameter. It may be mentioned that Perrin points out that several difficulties in connection with the kinetic theory arise solely from the fact that the same

expression "molecular diameter" is used to denote magnitudes which may be widely different: and he himself avoids ambiguities.

Chapters III. and IV., roughly a quarter of the book, deal with Brownian movements. Here Perrin deals with subjects which he has made peculiarly his own. He describes the experiments of himself and co-workers on the distribution of small uniform grains in a vertical column of an emulsion, and on the nature and magnitudes of the movements of grains or particles suspended in an emulsion. In dealing with the zig-zag movements of the particles, Perrin carefully points out that the displacements of the particles and not their apparent velocities are the magnitudes to be noted in practical work. This is important; and as the reviewer has met with misconceptions on the subject, he ventures to give a lengthy abstract.

"Einstein and Smoluchowski have defined the activity of the Brownian movement in the same way. Previously we had been obliged to determine the 'mean velocity of agitation' by following as nearly as possible the path of a grain. Values so obtained were always a few microns per second for grains of the order of a micron. But such evaluations of the activity are [illegible]."

Chapters V. to VIII. deal with the fluctuations in density [illegible] with chemical [illegible] the atom of electricity [illegible] of atoms. The [illegible] discussed in the earlier [illegible]

[illegible] exceedingly [illegible] subject.

A. [illegible]

The Range of Electric Searchlight Projectors. By JEAN REY. Translated by J. H. [illegible] (London: Constable & Co. Ltd.) Pp. [illegible] 12s. [illegible]

The first of the two parts into which this book is divided [illegible] and [illegible] relations to electric current [illegible] and the elementary theory of a parabolic reflector. The second part deals with the useful effect of [illegible]. The word range, an accurate translation of *portée*, is not defined. The formula on which this quantity is [illegible] Prof. [illegible] is here for the first time published. It contains a coefficient for the atmospheric absorption and another for the reflecting power of the object to be discovered, and takes into account the distance of the observer and of the searchlight from the object. The residual light which reaches the eye of the observer is thus calculated. It is obvious that the two coefficients mentioned include wide ranges of conditions, and in addition, the nature of the background, the acuity of vision of the observer and other matters must affect the result. A number of cases taken from practical experience in various parts Europe and at different seasons are examined, and the results are given as curves having illumination of the object as ordinates and the value of the probability that the object can be seen as abscissæ. The curves turn sharply upwards after a probability [illegible]

The bibliography [illegible] that it is based almost entirely on French experience and indeed mainly on the writings of Prof. Blondel, whose [illegible]

That law relates to illumination receive[illegible]

The explanation of the polar curve of the electric a[illegible]

[illegible] which have revolutionised the searchlight, a[illegible] of them have been described in the technical [illegible]

A. P. T.

FUEL RESEARCH.

A report of the Fuel Research Board on their scheme of research and on the establishment of a [illegible] research station has been issued. The report, which is signed by Sir George Beilby, the director of Fuel Research, states that in their first report* the Board announced that they had in view two main lines of research: (1) A survey and classification of the coal [illegible] mining districts by [illegible] and physical [illegible] the laboratory, and (2) an investigation of the practical problems which must be solved if a large proportion of the raw coal at present burned in its natural state is to be replaced by the [illegible] fuel obtained [illegible] [illegible]

[illegible]

* [illegible] report was [illegible] published.

industry, though undoubtedly valuable, is only indirectly useful so far as coal is concerned. As regards the carbonisation of coal at low temperatures there is no corresponding body of experience in existence, and there are very few properly accredited data available. Some work has been done by individual inventors and syndicates and a certain amount of experience has been gained. While only portions of this experience have been disclosed enough is known to justify the conclusion that much still remains to be done in devising the special forms of apparatus required for the economical carrying out of this type of carbonisation. The way is clearly open for a serious attempt to determine whether an economical and efficient apparatus can be devised for the carbonisation of coal at low temperatures and whether, by the use of such an apparatus for the carbonisation of properly selected coals, products will be obtained of a collective value greater than that of the original coal plus the cost of carbonisation and handling. The solution of these fundamental problems will supply a new base from which to attack questions like the following :—

(1) Can the 35 to 40 million tons of raw coal which is used every year for domestic heating be wholly or partially replaced by smokeless fuel, solid and gaseous, prepared by the carbonisation of this coal ? (2) Can adequate supplies of fuel oil for the Navy be obtained by carbonisation of the coal which is at present used in its raw form for industrial and domestic purposes ? (3) Can supplies of town gas be obtained more economically and conveniently by methods of carbonisation and gasification other than those at present in use in gas works ? (4) Can electric power be obtained more cheaply if the coal used for steam raising is first subjected to processes of carbonisation and gasification ? (5) Will the more scientific development of the preparation and use of fuel, which would be implied in the successful working out of the foregoing questions, enable the peat deposits of the United Kingdom to take a serious place as economic sources of fuel for industrial purposes ? (6) Can the use of gaseous fuel in industrial operations be forwarded by the development of more scientific methods of combustion in furnaces, muffles and ovens used in metallurgical, ceramic and chemical operations ?

The answers to these questions will only be obtained by co-ordinated research carried out on the lines of a broad and well-considered scheme. The subjects to be dealt with are already attracting the attention of serious workers in the industries, and it is to be expected that solutions of some of the problems will be supplied by these workers. The Board would regard it as a great misfortune if the establishment of a Government organisation for Fuel Research were to result in the discouragement or limitation in any way of the activities of outside workers or organisations. They venture to hope rather that many of these workers will be disposed to welcome a national scheme of research, the aims of which are broad and yet definite and in which the more specialised contributions from all sides will naturally take their place. In considering new and extensive schemes of carbonisation it is necessary to bear in mind that outlets for all the products of carbonisation must be found. The gas, coke and shale oil industries are all of old standing and each has had to develop outlets for its products by patient and continuous effort. No new carbonisation scheme can be justified economically if it can only live by poaching on the preserves of the existing industries. Even if an efficient method of low temperature carbonisation is evolved it will be valueless in the wider sense unless profitable outlets for all the important products can be developed. It is obvious that the Fuel Research Board, which is in official touch with the Admiralty, the Ministry of Munitions, the Board of Trade and other public departments, is exceptionally placed for the furtherance of schemes which involve the finding of large outlets for products new and old. It is known, for instance, that the Admiralty attach great importance to the development of supplies of fuel oil from home sources so that it may be taken for granted that this requirement alone would absorb all the oil which could be produced by the carbonisation of tens of millions of tons of coal per annum. This fact alone gives an entirely new aspect to the extension of carbonisation in hitherto untried directions, but while it will undoubtedly help on the economic side of the problem it in [illegible] the [illegible] on the technical side. In a way, moreover, [illegible] the [illegible] to, the profitable [illegible] left when the volatile [illegible] The [illegible] obtained [illegible] and the temperature at which it is [illegible] ton of coal [illegible] million [illegible]

[illegible]

standard of efficiency is reached. In the second stage the consumers of fuel must be induced to study the new apparatus and methods till they thoroughly understand and in the end adopt them. The use of town gas as a fuel for industrial purposes has made great strides during the past few years, and a number of experts are to-day engaged on the design and adaptation of furnaces and apparatus for these purposes. The actual practice of gas-heating still lags a long way behind the ideals of economy and efficiency and there is room for much useful experimental enquiry into principles and methods.

There is a very general belief among electrical experts that the future of British industry will be greatly affected by the cost at which power in bulk can be supplied in the form of electricity. It has been proposed, for instance, that large electrochemical works should be established in this country for the manufacture of products which in the past have been manufactured in parts of the world where cheap water power is available. In this connection it has been suggested that the cost of producing power from coal in this country would be substantially reduced if instead of burning the coal directly under the steam boilers it were first subjected to carbonisation and gasification processes which in addition to fuel gas would yield valuable by-products. Plausible statements have been issued showing the enormous savings or profits which would accrue if schemes of this sort were adopted. Unfortunately these estimates have generally been made on a very slender foundation of knowledge and experience. On the other hand those who by experience and practice are best qualified to judge, hesitate to prophesy as to what the economic result of a combined carbonisation and power generating scheme would be, but they agree that the interests at stake are so great that the question ought to be authoritatively answered once for all. But no answer can be accepted which is not founded on the complete working out of the scheme, no important step in the series of operations being omitted or slurred over. This series of operations will start from the mechanical preparation of the coal and its conversion into solid, liquid and gaseous products by carbonisation. It will end with the delivery of a known weight of high pressure steam under the conditions most favourable for power production by turbo-generators. In the proposed scheme of research it will be seen that the investigation of each of the step involved in the above enquiry is provided for. Three, at least, of these steps involve pioneering work on an industrial scale and the work may occupy a considerable time. The Board realise that it is possible that the net result of this particular enquiry may be to show that purely as a means of cheapening the cost of electric power, the use of carbonisation methods has not much to commend it, but that certain incidental advantages will justify its use in particular cases.

THE FUEL RESEARCH STATION.

The scheme of research which has been outlined in the report can only be efficiently carried out in a Fuel Research Station designed and equipped for the purpose in which operations on an industrial scale can be carried out under proper working conditions. The following is a description of the equipment which will be required for the research work at present in view :—

A railway siding will pass through or alongside of the station, and the coal to be used in tests will be received in railway wagons at an unloading platform provided with a sampling floor, a coal breaker and screens, a weighing machine, an elevator, and high-level bunkers from which the coal will be passed on to the retort house. In this house ample space will be provided for the erection of the various forms of carbonising apparatus which are under investigation. Facilities will be provided for quickly carrying out the necessary changes and improvements in the apparatus as the experimental work proceeds. The hot gases will be led from the retort house into the condenser and exhauster house which will be equipped with condensers, washers, scrubbers exhausters, compressors, meters, pressure regulators, gauges, pumps, motors, and tanks. For the collection and examination of the gases in bulk gas holders will be provided. The hot coke from the retort house will be elevated to high level bunkers from which it can be supplied to gas producers, steam boilers, briquetting plant or to railway wagons. The gas producer house will be provided with one or more gas producers with heat exchangers, washers, scrubbers and liquor tanks. The steam boiler house will be provided with one or more water tube boilers of modern type, and with feed water tanks, [illegible] steam meters, pumps, &c. The briquetting house will be provided with grinding, mixing, and briquetting machines. Tar and oil stills and condensers will be provided for dealing with the liquid products. [illegible] furnace house will be equipped for the testing of gas muffles, [illegible] ovens and melting furnaces. Laboratories, offices and workshops [illegible] suitably equipped will also be necessary.

The station [illegible] within easy reach of London; there should be ample railway [illegible] facilities for the transport of coal from all parts of the Kingdom. [illegible] should be ready means for the disposal of the large quantities of [illegible] oil and gas which would be produced in the [illegible] work and a supply of labour, skilled and unskilled, should be available. It was realised that these conditions could only be fulfilled [illegible] in the neighbourhood of a large gas works, and some months [illegible] Director of Fuel Research approached Dr. Charles Carpenter [illegible] subject. Dr. Carpenter, on behalf of the Board of the South [illegible] politan Gas Co., offered to lease to the Government [illegible] East Greenwich gas works for the erection of a [illegible] station [illegible] plans, drawings and specifications, &c., and ultimately a [illegible] agreed upon. The site is about 250 ft. wide by [illegible] ft. [illegible] on the main siding which connects the gas works with the [illegible] Eastern Railway and with access to an existing road. The [illegible] as planned, will be capable of any extension which will be required for future researches.

FURTHER NOTES ON A HIGH-TEMPERATURE THERMOSTAT.*

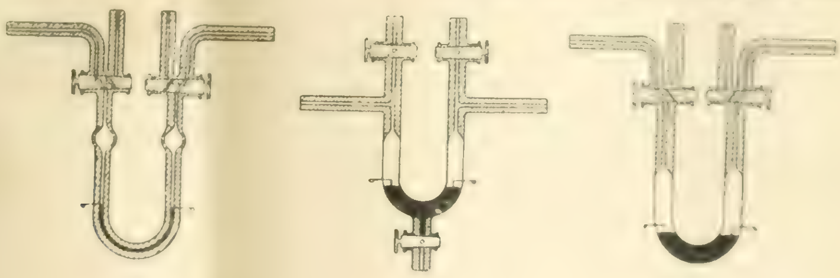
BY J. L. HAUGHTON, M.SC., AND D. HANSON, M.SC.

In a former Paper read before this Institute† the authors described a thermostat for moderate and high temperatures, but the apparatus there referred to was made of glass, and its use was, therefore, limited to temperatures not exceeding 500°C. The object of the present Paper is to describe certain alterations which have been made in the apparatus to render it suitable for much higher temperatures. The instrument consists of a double-walled vessel, similar in shape to a Bunsen ice calorimeter, which is made into a furnace by winding it with nichrome wire. This vessel acts as a gas thermometer, and the variations in the pressure of the air contained in it are used to operate a contact-breaker, which increases or decreases the current supplied to the furnace according as the temperature falls below or rises above the desired value. The contact-breaker takes the form of a **U**-tube containing mercury, fitted with two platinum contacts, which breaks the relatively small current of a "solenoid" relay; this in turn pulls a fork into or out of two mercury cups, by means of which an external resistance is cut out of or put into the furnace circuit. One side of this relay is connected to the furnace bulb, and the other is connected to the closed bulb of another thermostat, similar in principle to the main thermostat, but of much simpler construction; this device is necessary to render the instrument immune from the variations which would otherwise be caused by changes of atmospheric temperature and pressure. A device has also been added enabling extremely slow rates of cooling or heating to be obtained, if necessary, of the order of 1°C. or 2°C. [illegible]

The original form of **U** [illegible] serious disadvantage. If the current supplied to the furnace was cut off [illegible] the breaking of the bulb, while in the case of a silica one it was necessary to dismantle the apparatus in order thoroughly to remove the [illegible] **U**. [illegible] mercury and also to allow air to bubble through this mercury. In order to balance the effect of the expansion of this air with changes of temp[illegible] **U**-tube, as illustrated in Fig. 1, *C*. When, however, the wide-bore type of control tube is used, it is sufficient [illegible] between the contact and the taps, which space takes the place of the bulb. Finally, the control has been further simplified and improved by substituting one-way taps for the two-way taps formerly employed, connection with the furnace and old [illegible] means of side arms below the taps in the manner shown in Fig. 1, *E*. The limbs of the **U**-tube can then be brought closer together, and the volume of the mercury still further reduced. The additional tap shown [illegible] becomes fouled, without having to dismantle the [illegible]

The [illegible] the ozone produced by the spark discharge when the contact is broken [illegible] by connecting a condenser and resistance across the [illegible]

[illegible] thermos flask, which it was not far from filling, the remainder of the [illegible]



C. E. D.

FIG. 1.

In order to use the thermostat for temperatures of the order of 1,000°C., a silica furnace bulb was constructed, and by its aid curves were taken with the furnace running at about 800°C. The temperature scale was such that one division of the paper represented [illegible] and the minor variations of the temperature are of the same order as the error of the thermal recorder [illegible] in the extremely sensitive [illegible] used at the National Physical Laboratory is not adapted to recording to an appreciably greater accuracy than 1°C. with a platinum platinum-rhodium thermocouple.

On the other hand, a temperature record from the same furnace running from the ordinary power supply of the laboratory, when the thermostat control was not used, recorded a variation of nearly [illegible] the daytime, when current is being taken [illegible] while during the night the variation was of the order of [illegible]

The original form of **U**-tube suffered from several disadvantages. [illegible]

[illegible] 100 volts [illegible]

* Abstract of a Paper read before the Institute of Metals.
† Journal of the Institute of Metals, No. 2, 1915, Vol. [illegible] pp. [illegible]

acts as an expanding liquid, and operates the mercury contact-breaker D, while in this case also the f ll current is broken in the benzene, which appears to be undecomposed by the spark, and the surface of the mercury keeps quite clean. The third cylinder, C, contains thermal insulation. This apparatus has proved very satisfactory in use, and it has not been found possible to detect by means of a thermocouple inserted in the tube E a change as great as 0·1C. in the temperature of the bulb A.

While the maintenance of a constant temperature is a matter of great importance in many operations, it is sometimes desired to obtain extremely slow cooling over a limited range of temperature, as, for example, through a thermal critical point. By using a very poor thermos flask in which to keep the cold bulb, a slow rise of temperature is obtained in the bulb, and consequently in the thermostat. If, then, a gradual fall of temperature could be obtained in the cold bulb, it would be accompanied by a corresponding fall in the furnace itself. It would, of course, be possible to do this by immersing the bulb in a thermos flask containing water at a higher temperature than that of the atmosphere, but there are certain drawbacks to this method. If the rate of cooling in the furnace is to be very slow, the fall in the thermos flask must also be slow—*i.e.*, the water must be near room temperature. Under these circumstances, the rate of cooling will fall off rapidly as the water approaches room temperature, and the cooling of the furnace will not be uniform, while the effects due to changes of room temperature will be increased. On the other hand, if the water in the thermos flask is sufficiently above room temperature to make the fall reasonably uniform over the whole of the period, the rate of cooling becomes excessive. To overcome this a subsidiary, but very much smaller, bulb was inserted in parallel with the cold bulb, and immersed in hot water in a thermos flask, so that but a fraction of the total air was cooled. In this way the change in the pressure of air in the cold bulb side of the apparatus could be varied between very wide limits with corresponding variations in the rate of fall of the temperature in the furnace, merely by altering the volume of the controlling bulb, while the fall in the furnace is made independent of the actual fall in the thermos flask.

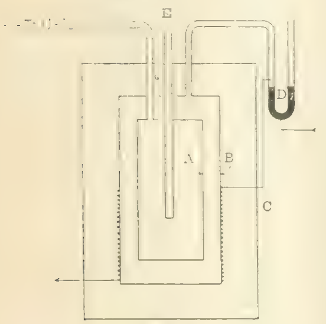


FIG. 2.

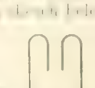
In an instrument of this kind the electrical connections tend to become very numerous, and it has been found very convenient to mount the whole on a large wooden base, the connecting wires being led underneath the board to a set of terminals in front, by means of which all the wiring is controlled. If it is desired to use the apparatus for high and low temperatures, a complete set of resistances [illegible] [illegible] to work on a single voltage.

CORRESPONDENCE.

FAILURE OF FUSE CLIP HOLDERS.

[illegible]

[illegible]



[illegible] paragraph 219 [illegible]

It would be of [illegible] to know whether such failure [illegible] alternating current [illegible] effect being altogether negligible, also whether some alloys are more subject to it than others.

The section at a along the line of fracture was about 8·5 × 1·2 millimetres, and there was no trace of any corrosion.—I am, &c.,

London, Oct. 11. W. H. F. MURDOCH.

USING THE PHOTOELECTRIC CELL AS A PHOTOMETER.*

BY JAMES R. RANDOLPH.

Photo-electric cells, developed by Dr. Kunz or the physics department of the University of Illinois, have been in use for some time for measuring the light of stars. It has been suggested that for certain kinds of photometry they would offer advantages over methods now in general u e, and the writer has undertaken a series of tests on this point.

Fundamentally, the photo-electric cell consists of a wire grid and a thin film of some metal such as potassium enclosed in a glass bulb containing argon under low pressure. The film is connected to the negative side of the circuit and the grid to the positive side. When light shines on the film it gives off ions which convey small charges of negative electricity to the grid, thus causing a current of sufficient strength to be detected by a sensitive galvanometer or electrometer. The strength of this current has been shown to be directly proportional to the intensity of light reaching the cell for a given quality of light, *i.e.*, inversely proportional to the square of the distance between the source and the cell. This greatly simplifies the calculations, and would thus permit the use of the photo-electric cell in photometry where a large number of readings had to be taken, as in determining the distribution of light from lamps, shades, &c., or for determining the distribution of light in a room.

For the test two lamps were used, a 40-volt tungsten lamp having a filament made of four coils set in a row, and an ordinary 120-watt carbon-filament unit.

The lamp to be tested was mounted on a graduated revolvable circle sliding on the photometer bench. Near the end of this photometer bench was a box containing a photometric cell and having a small opening with a shutter in the side toward the lamp through which the light could reach the cell.

The circuit containing the photo-electric cell consists of a battery whose negative terminal is grounded), while the positive terminal is connected through a 10,000-ohm resistance to the grid, or positive terminal, of the photo-electric cell. The negative terminal of the cell is connected to ground through the graphite resistance, across whose terminals an electrometer is connected. In the circuit supplying the lamp are an ammeter and an adjustable resistance so that the current may be kept constant during a test. For the photometer tests a 16-c.p. standard carbon lamp and a Lummer-Brodhun photometer were used.

In starting a test the lamp was lighted and allowed to burn until current through it became constant. Then the lamp was turned until the pointer on the graduated circle stood at zero degrees, when the shutter was opened. After the electrometer deflection was read the shutter was closed until the electrometer indicator rested on zero, when the shutter was opened again and another reading taken. The average of the two readings was used. The shutter was closed, the lamp turned to a [illegible] angle, and the process repeated. In this way a series of readings was obtained for different positions of the lamp.

By moving the lamp on the photometer bench light intensities of 1 to 100 candle [illegible] were secured. The ratios between intensity of illumination and corrected deflection proved to be almost exactly constant. When, therefore, this ratio is known, candle-power can be obtained from deflection by simple multiplication. (The deflection of an electrometer is not exactly proportional to the current, but within the limits of this experiment the error is inappreciable.)

According to these tests it appears that the photo-electric cell in its present [illegible] development can be used as a photometer, provided the ratio between candle power and electrometer deflection is known for the [illegible] to be tested. It will be especially valuable for [illegible] where [illegible] must be drawn showing the variation of intensity from [illegible] point, as the readings may be reduced to candle power by [illegible] multiplication, and by watching the galvanometer while [illegible] or the source of light is moved, the important point [illegible] can be located and the number of readings thus reduced. [illegible] units, for instance, reflectors of high intensity, have [illegible] measured in different directions, the space required for [illegible] photometer is very large. The method employing a photo-electric cell and [illegible] galvanometer would require only about one-tenth [illegible] this space or less.

* Abstract of an article in the "Electrical World."

TELEPHONE DEVELOPMENT IN THE WORLD AT THE BEGINNING OF 1917.*

BY W. H. GUNSTON.

In the absence of many official returns, it is not possible to give a precise statement of the world's telephone development since 1914. One may, however, form a rough estimate. America is amongst those countries whose figures are not founded on conjecture, so also is Canada, and these exceptions are important, seeing that North America contains nearly three-fourths of the telephones in the world. Official figures up to varying dates have been obtained from New Zealand, South Africa, Russia, Sweden, Norway, Denmark and Switzerland, whilst newspaper reports have furnished recent data relative to Japan, Brazil and other places.

Europe, which had 3,910,000 telephones at the beginning of 1914, had at the beginning of the current year probably 4,180,000, made up as follows:—

Country.		Total stations.
Great Britain (including emergency stations)		812,000
Russia (January 1, 1916)		400,000
Sweden (271,797 at January 1, 1916)	say	288,000
Denmark (150,000 at January 1, 1916)	say	165,000
Norway (94,000 in January, 1915)	say	100,000
Netherlands (78,743 at January 1, 1914)		100,000
Switzerland (January 1, 1917)		104,000
Spain (36,000 at January 1, 1915)	say	50,000
Austria (170,000 at January 1, 1915)		170,000
Germany (pre-war)		1,421,000
France (pre-war)		310,000
Italy (pre-war)		95,000
Belgium (pre-war)		51,000
Hungary, the Balkans, Portugal, Luxemburg, &c. (pre-war)		114,000
		4,180,000

Nothing has been added in this estimate to the pre-war figures for France, Germany and Italy, to the 1915 figures for Austria, or to the 1916 figures for Russia, in view of the complete lack of information regarding the development of the telephone in those countries in recent years and the small probability of any considerable expansion. The telephone system of the Netherlands had been increasing up to 1914 by 7,000 to 8,000 a year, and there is no reason to suppose that this increase has not been maintained. Belgium's total has undoubtedly decreased, but against this may be set the probability of some increase in Portugal, Roumania and Greece. It is satisfactory to note that Great Britain has increased from the pre-war figure of 774,000. Even if the "emergency stations" be [illegible] a small [illegible] is still shown. London, [illegible] in the Press to the contrary, has increased from [illegible] to [illegible]. Again, even if the emergency stations were disregarded, the movement would be seen to be in the right direction.

ASIA.

Asia had 203,000 telephones at the beginning of 1914. Since then there has been an increase of [illegible] in Japan, 6,000 in Siberia, and [illegible] in Korea, Manchuria and Formosa. Making [illegible] for the [illegible] in the Dutch East Indies [illegible], and some development in China and British India [illegible] the total for Asia at [illegible].

AFRICA.

There were [illegible] telephones in Africa in 1914. The figure for South Africa [illegible] by [illegible] for the beginning of 1916. [illegible] in Egypt, Algeria and Tunis, I should [illegible] that there were at least [illegible] stations in Africa at the [illegible] of that year.

NORTH AMERICA.

[illegible] that there were 11,500,000 telephones in the United States. Canada had [illegible] at [illegible], 1914. At the [illegible] rate of increase [illegible] would be [illegible] by [illegible]. The [illegible] Mexico and the West Indies [illegible] had [illegible] before the war. [illegible] North America [illegible] 11,[illegible].

[illegible] SOUTH AMERICA.

[illegible] South America no information [illegible] telephone development in Brazil. There were about [illegible] telephones [illegible] in 1914, and as the Argentine and Brazil [illegible] a year, there cannot be less than [illegible] stations working at present.

AUSTRALASIA.

Official figures show that there were 168,416 telephones in Australia on June 30, 1916. [illegible] Total 234,000. To resume:—

Europe	[illegible]
Asia	[illegible]
Africa	[illegible]
North America	[illegible]
South America	[illegible]
Australasia	[illegible]
Total	[illegible]

In January, 1913, there were about 13,500,000, and in 1914 14,500,000, telephones in the world. It will be seen that at January, 1917, there must have been close upon 17,000,000.

* From the "Telegraph and Telephone Journal," [illegible]

SHEFFIELD ELECTRICITY UNDERTAKING.

Last week the chairman of the Electric Supply Committee (Councillor Warlow) drew the attention of the Council to the accounts in the report which had been published, and said the Committee wished to express their appreciation of the [illegible] and [illegible] sympathy with the relatives of those employees who had given their lives fighting for their country.

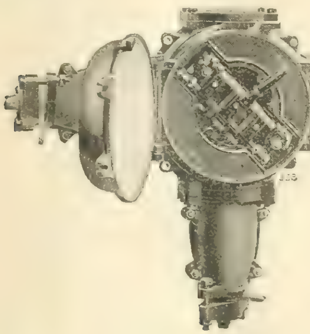
The Committee [illegible] with reference to the [illegible]. He [illegible] their notice the cost of [illegible]. The [illegible] sold by the undertaking [illegible] rents, rates, taxes, and [illegible]. He had taken the figures of some of the [illegible] municipal electricity undertakings and found that [illegible] for Birmingham, 0·951d. for Manchester, 1·194d. for Liverpool, [illegible] for Leeds. [illegible] comparison. For Sheffield [illegible] Manchester 1·034d., Liverpool [illegible] the balance of [illegible] 0·029d., Birmingham [illegible] and Leeds 0·05d. [illegible] takings were: Sheffield [illegible] £2,[illegible], Manchester [illegible], Liverpool [illegible], and Leeds £1,062,927. [illegible] March, 1917 [illegible] 149 [illegible].

[illegible]

TRAILING CABLE SOCKETS AND DISCONNECTORS.

There are many portable tools in use which require comparatively large amounts of power and necessitate heavy trailing cables. Such long lengths of cable are apt to be inconvenient and wear out quickly, and it is often better to instal plug sockets at frequent intervals and protect each socket by a switch or circuit brealer capable of interrupting the heaviest current. A recent list issued by George Ellison contains particulars of a variety of appliances of this kind, which appear to be very compact in construction and well adapted to industrial use.

Another convenient accessory listed by the same firm is illustrated in the adjacent figure. This shows a disconnector such as can be applied to cables branching from distribution networks or from switchboards



DISCONNECTOR (OPEN).

installed at various feeding centres. The disconnector affords a means for isolating a section of a system during temporary repair. The essentials of the apparatus will be understood at once from the figure, but it may be remarked that among other qualifications the disconnector must carry the full capacity and reasonable overloads without undue heating, must be suitable for any kind of cable coming from any direction, above or below ground and exposed to the weather, and must be capable of being inserted in existing cables without jointing lengths to the same. These and other requirements are stated to be satisfactorily met and a substantial earthing terminal is provided.

The disconnector illustrated is open, showing the metal parts at which break and make is made. It should be understood that such apparatus is merely intended to isolate sub-sections, individual motors, &c., and is not intended to be operated while the current is flowing.

LEGAL INTELLIGENCE.

Elwell v. Universal Radio Synd. (Ltd.)

[illegible] was mentioned to Mr. Justice Lush on Monday.

For plaintiff Mr. WHITEHEAD said he desired to draw attention to the action of which plaintiff's counterclaim was outstanding. Plaintiff applied, as defendant, that the case should stand out till next sittings. [illegible] and wireless expert, and the [illegible] certain contracts he entered into with the British Admiralty and the French Government. The [illegible] were really fraudulent contracts in the [illegible] entered into with defendant. Plaintiff [illegible] of the Universal Radio Syndicate, [illegible] plaintiff, and paid money into court.

[illegible] Mr. [illegible] K.C., said their case would be that plaintiff [illegible] knowledge and returned them back, [illegible] put the money in his own pocket.

[illegible] Mr. Elwell was, of course, a material witness. [illegible] French Marine, which stated that he [illegible] the moment. Mr. Elwell, who was on [illegible] in France [illegible] instructed to [illegible] apparatus on [illegible] should stand out [illegible] would consent [illegible] country [illegible] months into [illegible]

[illegible]

Holt v. A.E.G. Electrical Co.

On Tuesday Mr. Justice Younger was asked on behalf of the plaintiff to adjourn the action generally, with liberty to restore.

Mr. GALBRAITH said plaintiff, who was the central witness, was serving at the Front. The action was on an agreement of service, for a declaration that defendant company was bound by the agreement, and for damages.

Mr. C. J. CONWAY (for defendants) said the entire claim rested upon written documents, and the defence was that certain letters were not binding upon the company, and that they were *ultra vires*. If this defence failed the amount due could be easily found. Defendants said that consent of the Board of Trade had not been obtained, the company being in the hands of a controller. On this point they were anxious to get his Lordship's decision, as there were other cases depending upon it.

Mr. GALBRAITH said plaintiff was employed as the commercial manager of the company at their head office in London, and was now a private in the British Army in France. The agreements were traversed, and it was alleged there was no consideration for them.

Mr. CONWAY said for the purpose of coming to trial early he thought he could waive the question of no consideration.

His LORDSHIP said, subject to the question of no consideration being waived, the case would take its ordinary course. The case could not come on before Monday week.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until the acceptance of Complete Specifications. Those marked * are open to inspection 18 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

September 18, 1917.

13,392 AUTOMATIC TELEPHONE MFG. CO. (Automatic Electric Co.). Telephone systems.
13,399 PARATARE. Electric and mechanical apparatus for d.c. motors.
13,406 B.T.-H. CO. (G. E. Co.) Manufacture of composite bi-metallic articles.
13,407 IGRANIC ELECTRIC CO. (Cutler-Hammer Mfg. Co.) Liquid rheostats.
13,420 APEX ELECTRICAL ACCUMULATOR SYND. & WILLNER. Accumulator electrodes [illegible]

September 19, 1917.

13,425 JEFFCOTT. Speed-controlled electrically operated machines.
13,441 KIMURA. El[illegible] of water.
13,451 CROSBEE & WILKS. Sparking plugs.
13,462 THOMPSON. E[illegible] carbons.
13,469 B.T.-H. CO. (G. E. Co.) Manufacture of incandescent lamps, &c.
13,473 POLLOCK. Rectification of a.c. currents.
13,474 SIMS. Electric water heaters.
13,475 SIMS. Electric thermostat.
13,476 SIMS. Electric changing switch.

September 20, 1917.

13,520 HALL. Electric flask lamps.
13,527 LIGOTTI. Armature without commutator for d.c. machines and s.p. motors.
13,536 BLYTON. Magnetic induction wire.
13,541 WESTERN ELECTRIC CO. Telephone exchange systems. (22/9/16, U.S.)
13,542 & 13,543 O[illegible] LAMP WORKS & DURLE. Means for supporting electrodes in ionic tubes for use in wireless telegraphy, &c.
13,544 B.T.-H. CO. (G. E. Co.) Electric furnaces.
13,547 EVANS-JACKSON. (Pothoff.) Electro-plating apparatus.
13,551 DAWSON & FAWDRY. Trolley wire systems for electric railways, tramways, &c.
13,559 MUNN. Motors.

September 21, 1917.

13,615 BENNETT & GARDE. Electric switches.
13,616 WE[illegible] & B[illegible] magnetic [illegible] out switch.
13,627 BENJAMIN ELECTRIC (LTD.) & FOWLER. Locking, &c., devices for incandescent lamps.
13,631 H[illegible] installation.
13,633 CLAXTON. Keyed interrupter or cut out for electric installations, &c.

September 22, 1917.

13,677 B[illegible] W[illegible] & M[illegible] Ampere-hour meters.
13,681 B[illegible] Detective [illegible] for electric [illegible]

VOLUNTEER NOTICES.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

Headquarters: Balderton street, Oxford street, W. 1.

Orders for the Week.

Lieut.-Colonel C. B. Clay, V.D., Commanding.

Officer for the week. Lieut. C. E. Campbell.
Next for Duty. [illegible] W. J. A. Watkins.

Drills. Week ending Saturday, Oct. 27, 1917.

Monday. No. 3 Company, Left Hall. Recruits. Signalling, 6.30.
Tuesday. Physical [illegible] Drill and Bayonet Exercise, 7.30.
Wednesday. No. 1 Company, 6.30.
Thursday. No. 2 Company, 6.0. Signalling. Ambulance, 6.30.
Friday. No. 3 Company, Right Hall. Recruits, 6.30.
Musketry. Belvedere road, Tuesday, Wednesday and Thursday, 5.30 to 7.
Note. The Medical Officer will attend for Examination of Recruits, &c., on Thursday at [illegible]
Unless otherwise indicated all drills take place at Headquarters.


Osram
G·E·C·
DRAWN WIRE
Lamps
OSRAM
PATENT
G·E·C
MADE IN ENGLAND
MAKE
SURE
IT'S AN
OSRAM

COMMERCIAL & INDUSTRIAL SECTION.

Supply of Raw Materials.

The Minister of Reconstruction, Dr. Addison, after consultation with the other Government Departments concerned, has appointed a committee to consider and report upon questions connected with the [illegible] which will be required by British industries for restoring and developing trade after the termination of the war, and the best means of securing and distributing supplies.

[illegible] through the ordinary commercial channels, to consult members of the [illegible] guard the needs of industry and to secure convenient and equitable distribution.

[illegible] Sir Henry Birchenough, K.C.M.G., Mr. Cecil Budd, Sir Charles W. [illegible] Mr. J. F. Bowes, Board of Trade [illegible] addressed at the Ministry of Reconstruction, 2, Queen Anne's Gate Buildings, Westminster, S.W. 1.

* * * *

Distribution of Engineering Products Overseas.

At the meeting of the members of the Engineers' Club last week, Mr. C. Hamilton Wickes, H.M. Trade Commissioner in Canada, who opened a debate upon the above subject, said that "any fool could obtain orders, but it took an efficient distributing organisation to make them profitable."

[illegible] Mr. Wickes made in his address was the necessity for all firms who aimed at doing overseas trade to have an [illegible] resembling a consulting [illegible] whose business it was to be thoroughly acquainted with every detail from practical knowledge in the [illegible] The duties of the commercial [illegible] would be [illegible] the means by which the production might be improved or waste prevented, to have knowledge of the latest types of machinery to cheapen production and increase the turnover. The commercial engineer must be a thorough technically trained [illegible] Mr. Wickes made several recommendations for improving the distribution of the products of the British engineering industry, including the employment of [illegible] the use of the services of the recently organised trade bank, as well as the information obtained from the freshly consolidated departments for the Imperial Intelligence [illegible] department and the [illegible]

* * * *

Economy of Electric Power in Oilfields.

At the recent meeting of the Kern River Oilfields, of California [illegible] part of the economy effected [illegible] watching small details of [illegible] power formed [illegible] Electric power [illegible]

[illegible]

[illegible] per annum, while the cost of the electric [illegible]

* * *

Electrical Opportunities in South America.

[illegible]

in any of these countries, with [illegible] Guayaquil, in using conduit as [illegible] damaged wires, as all the houses [illegible]

[illegible] on account of freight and duty charges, is qu[illegible] largely for this reason that not even the Europ[illegible] are used to any extent. Rigid conduit is in fav[illegible] with companies which are formed with American [illegible]

[illegible] and not jobbers who pretend to handle A[illegible] hold agencies for manufacturers in the St[illegible]

* * * *

Canadian Electrical Imports.

The total value of the Canadian [illegible] during the fiscal year ended March 31, 1917, was [illegible] compared with [illegible] $176,700 came from the United Kingdom and [illegible] per cent., from the United States.

[illegible] facturers have Canadian [illegible] Canadian consumption at [illegible] avoid import duty.

* * * *

Trade After the War.

[illegible] the prospects of trade and industry after the war.

[illegible] of view they were [illegible] They felt convinced that [illegible] led away from the essentia[illegible]

[illegible]

* * * *

American Steel Prices.

[illegible]

ELECTRICITY SUPPLY.

EXTENSIONS.

Carlisle.—On the recommendation of the Electricity Committee, the Council decided last week to make a renewed application to the Ministry of Munitions for sanction to instal an additional generating set at an estimated cost of £9,000, in order to meet the increasing demand for supplies of electrical energy.

Mr. Gibbings stated that in view of the increasing demands for power from consumers, most of whom were engaged on engineering work, the committee found that their present plant was insufficient to guarantee a regular supply, and they had therefore decided to ask the sanction of the Council for a further application to allow the purchase of an additional set.

Darlington.—It has been decided to lay an additional main to the Dodsworth-street sub-section, and also the extension of the sub-section, at a cost of £3,000.

Ald. Sir CHARLES STARMER stated that, owing to the difficulty in getting meters it was intended to charge domestic consumers of electricity for heating and cooking 4d. per unit for electricity consumed up to the amount consumed during previous corresponding quarters, and 1½d. per unit for all units consumed above that number of units, the amount to be paid by any consumer to be not less for any six months ending June or December than the amount fixed for the lighting supply, plus 20s. for heating or cooking. The revenue from the tramcars for the six months just ended was £809 in excess of last year, and the output of electricity showed an increase of 61 per cent. over last year up to the present date.

Ald. STEWART asked if it was possible for the Electricity Committee to let cookers on hire as the Gas Committee did.

Ald. LEACH thought it was a waste to have two meters, and suggested a flat rate, as in Sunderland, based on the rental of the house.

Mr. FREEMAN inquired whether the temporary system of charging in regard to heating and cooking supply was merely a makeshift or was there any possibility of its being put on a permanent basis.

In reply, Ald. Sir CHARLES STARMER hoped the time was not far distant when the Electricity Committee would find themselves with the same powers as the Gas Committee. It was rather difficult to fix a flat rate with their present experience. The charge for lighting in Darlington was as cheap as in most towns of a similar size, and the same applied to electricity supplied for power. They were making both ends meet.

London County Council.—On Tuesday sanction was given to Poplar Borough Council to borrow an amount not exceeding £27,825 for a new turbo-generator.

Manchester.—The Corporation is recommended to apply for sanction to borrow £20,000 for mains extensions.

Nuneaton.—Application has been made to the Local Government Board for sanction to borrow £2,140 for new mains and services.

Salford.—Various improvements are to be carried ont at the docks, including the installation of electric plant.

GENERAL.

Bath.—The salary of the deputy electrical engineer (Mr. A. R. Shapley) has been increased by £25 a year.

Cardiff.—The Wages Committee recommends the Council not to concede the demand of the employees of the power stations and tramways depots for an increase in their war bonus from 6s. to 15s.

Derby.—At the recent meeting of the Corporation it was announced that the British Cellulose were arranging to put down their own plant for generating electricity.

Increased Charges for Electrical Energy.—The charges for current at the following places are being increased:

[illegible] Council has decided that in future agreements the prices be [illegible] as follows: direct current system minimum annual payment [illegible] from 0.8d. to 0.875d. per unit; three-phase high-tension (annual [illegible]) from [illegible] to 0.375d. per unit.

[illegible] Corporation is increasing its charges by 20 per cent. [illegible] for power and heating [illegible] 30 per cent. increase in all, for lighting. The [illegible] is to be continued.

[illegible]

[illegible]

[illegible]

[illegible]

It is proposed to increase the charges at Bethnal Green (London) by 33 per cent.

Worcester Council has decided to make an increase of 10 per cent. (making 20 per cent. over pre-war rates) for lighting, heating and power, except to consumers having agreements for an unexpired term of years.

Walthamstow Council has increased its charges for current for public and private lighting by a further 5 per cent., making 25 per cent. over pre-war rates, and for power and heating by 8⅓ per cent., making 33⅓ per cent. in all.

Stepney Council is increasing its rates (except in cases where there are special contracts) by 16⅔ per cent., making a total increase on pre-war rates of 50 per cent., as from Oct. 1.

Leith Corporation is increasing its charges from 1½d. to 1⅞d. net for power, and from 4½d. to 4¾d. net for lighting.

Stafford Council is increasing its charge for current for power by 10 per cent. in addition to the 20 per cent. already added to the pre-war charges.

Lancashire Linking-up Scheme.—At the meeting of the Manchester Electricity Committee last week the scheme for the linking-up of the Lancashire & Cheshire Electricity Works (as outlined in the recent report of the Committee of the Electrical Engineers) was under consideration.

It is suggested that a scheme on the lines indicated should be proceeded with at once, and that the proper authority to control this undertaking would be a local joint board. In some districts it might be desirable to increase the capacity of existing stations, while in others it might be necessary to erect new stations. Among the advantages claimed are a great reduction in the yearly costs of the undertakings, an enormous saving of fuel and of working expenses. The scheme is urgently required in order to meet the ever growing needs of factories for an increased supply of current, and the difficulties of municipalities in obtaining money for extensions of works.

The chairman of the committee (Councillor Dagnall), the deputy chairman (Ald. Walker) and the chief engineer (Mr. S. L. Pearce) were authorised to attend any further conferences that may be held on the subject.

Liverpool.—The Corporation has granted the increases of salary to the city electrical engineer (Mr. H. Dickinson), to the general manager of the tramways (Mr. C. W. Mallins) and to other officials of the tramways and electricity departments which were set out in our last issue.

Loughborough.—In recognition of his public services, the freedom of the borough has been conferred on Ald. A. A. Bumpus, chairman of the Electricity Committee.

Marsden.—A special meeting of the Urban Council was recently held to consider the advisability of applying for a provisional order. Mr. Schofield attended by invitation, and advised the Council not to apply for such order at present owing to the exceptional prices, &c. It was decided to ask the Yorkshire Electric Power Co. to state how soon they would undertake to supply electricity to the district after the war.

Middleton.—The question of coal economy was discussed by the Council last week.

It was stated that the inspector appointed by the Coal Controller had visited the electricity works and had gone into the question of coal which would be saved in the event of the carrying out of the scheme for taking a bulk supply of electricity from Manchester, and converting the present works into a transforming and distributing station.

Ald. BENTLEY said the inspector was quite in agreement with the idea that it would save thousands of tons of coal.

Paisley.—The Council has granted the following increases of salary to the staff of the electricity department:

Shift charge engineers, advance 3s.; switchboard attendants, 2s.; engine drivers, 5s.; firemen, 5s.; storemen, 3s.—All per week. Labourers' wages were fixed at 9d. per hour.

Presentation.—On Monday the employés of the Newcastle-upon-Tyne Electric Supply Co.'s power station at Dunston presented a clock and two silver watches and alberts to Messrs. C. W. B. Roll, E. McFarlane and F. Watson for gallant rescue work at the power station on July 5.

South Shields.—The borough electrical engineer (Mr. Harry S. Ellis) has been appointed the representative of the Coal Controller for Northumberland and Durham.

Workington.—The Council has decided to apply for a provisional electric lighting order.

LIGHTING AND INDUSTRIAL POWER.

Electric Power in Dockyards.—At a recent meeting of the Dublin Port and Docks Board, Mr. Sherlock referred to a suggestion made at a previous meeting that a tunnel for the electric cable should be made between North and South Walls.

There had [illegible] been a tremendous development of industry on the north side of the [illegible], and the Board would be face to face with the fact that in order to supply electric power to various firms there they

would have to go to considerable capital expenditure. A proper tunnel might be made without considerable cost. It would be of enormous advantage if the tunnel were made to take pedestrian traffic, and would facilitate business. The question should have the consideration of the Board and the Corporation jointly, and he would suggest that the engineers of both bodies should confer.

The Lord Mayor said there was at present on the north side a demand or electricity which could not be satisfied. It was considerable, and was bound to grow very considerably. He thought it was a very good commonsense suggestion that the Corporation and the Board should assist one another and exchange views upon the subject.

The engineers said that the whole question of the port's electrical equipment was ripe for discussion.

Mr. Scott thought the co-operation suggested was very desirable. There was a large demand for current on the north side. There were no other means of getting power. A pedestrian tunnel would fulfil a great public want, assist trade and would in many ways be of great value to [illegible] industrial side.

The suggestion was then adopted.

A new shipyard is being equipped on the Wear for the Egis Shipbuilding Co., and electricity will be employed throughout for power and lighting. Current will probably be taken from the Corporation. When completed it is expected that between 2,000 and 3,000 men will be employed in the yard.

Hales Owen.—As the Rural Council has been informed that no public lighting will be permitted during the winter months unless arrangements can be made for the lights to be extinguished within [illegible] upon receipt of an air raid warning, it has decided to proceed upon the same lines as last year and to light none of the [illegible].

Poor Law Institution Lighting. [illegible] Guardians have instructed Mr. J. P. Tierney, electrical engineer, to report on the proposed [illegible] of electric lighting in the institution, and on the question [illegible] gas or oil driven plant should be used.

Ruthin. The Council has offered to pay the local electric supply company £100 per annum for the street lighting.

ELECTRIC TRACTION.

Bradford. At Monday's meeting of the Tramways Committee an application was received for an advance in wages of £1 per week over pre-war rates from the Amalgamated Association of Tramway and Vehicle Workers.

[illegible] 12[illegible] pre-war rates, with pay at the [illegible] and a half for overtime [illegible] additional 8s., combined with [illegible] would cost £42,000 per annum. [illegible] to grant the new demand [illegible] referred the question to the War Wages Committee, with [illegible] that the advance be not granted. The committee, however, are willing that the matter should be [illegible] arbitration.

Dover. The Tramways Committee recommends the Corporation [illegible] claims arising out of the recent tramway accident. The committee has approved a scheme for levelling [illegible] the hill where the accident occurred.

Glasgow. The Cleansing Committee recommends the purchase of [illegible] electric vehicles for the collection of refuse, and the [illegible] recommend that two [illegible] 2-ton electric vehicles be purchased at an approximate cost of £1,000 each.

L.C.C. Tramways. At the [illegible] meeting of the L.C.C. [illegible] the Highways Committee reported that for the 11 weeks ended [illegible] number of passengers carried on the Council's [illegible] and the receipts for the same period [illegible] 169,325 in the number of [illegible] of 881,111 in receipts, compared with the corresponding period last year.

[illegible]

Trackless Trolleys in War. The [illegible] Gazette [illegible] trackless trolley method of utilising the [illegible]

tried traction [illegible] the economy of a central power [illegible] use for military purposes.

[illegible] road traffic [illegible] civilian movements are few, while it is handled under a highly-organised system of control. [illegible] that the [illegible] played by road transport [illegible] efficiency of the latter is of the first importance. From this standpoint the trackless trolley [illegible]

Tube Railway Ventilation.—Correspondents in the Press having suggested that [illegible] of the tube railways might be put out of action, the [illegible] London Electric Railway Co. has issued the following [illegible]

"We are [illegible] in the tube railways unsafe. The tube railways ran for a [illegible] years without any artificial ventilation whatever. There is [illegible] considerable ventilation [illegible] quite sufficient in itself to prevent the air b[illegible] shutting down of the whole of the electrical suppl[illegible] Railways would not affect the running of the fans [illegible] alternative means of power supply from a quite [illegible] Individual damage [illegible] out of commission [illegible] ventilation going."

IMPERIAL NOTES.

Australasia. The [illegible] Public Works Department [illegible] installation in the town of W[illegible] (N.S.W.) [illegible] divert to the town the cable for the Cordeaux dam [illegible]

The Council has decided to take steps to obtain money to establish its own electricity works.

Electric lighting [illegible] Board for the lighting of the cable tramway cars and tenders for the installation work [illegible] at the car sheds are to be used.

Q[illegible] N.S.W. [illegible] to establish an electric supply undertaking in the town.

[illegible]

British Guiana Bauxite Deposits. Th[illegible] were almost concluded bef[illegible] after the war. The whol[illegible]

Canadian Electric Power Exports. [illegible]

Platinum in Canada. [illegible]

South Africa. [illegible]

electric lamps are now so scarce in South Africa that those supplies presumed to be on the water are being disposed of on "to arrive" terms.

Notwithstanding the war, new irrigation projects continue to take tangible shape throughout the Union of South Africa. Government works now in hand are making slow but steady progress, and the programme set out in the Loan Estimates for the current year, involves an expenditure of about £700,000. These are merely the forerunners of other irrigation works which will involve the provision of plant and appliances on a scale which British manufacturers so far have no conception. Though a good deal of the money allotted for these schemes will be expended upon cement, bricks and other locally-produced materials, nevertheless a respectable proportion of it will be available for purchases of plant and machinery overseas, in the supply of which the United Kingdom will naturally be given preference. As our contemporary observes: "It is more difficult to say what of the products of an engineering firm do not go to the equipment of a great irrigation of public works undertaking than what do. Cranes, overhead runaways, pulley blocks, hoists, engines, chains, tramway plant, high lift pumps, conveyers, transformers, motors, dynamos, meters, metal gear, instruments telegraph and telephone ironwork, insulating materials, lamps, iron and steel tubing of all dimensions, windmill pumps, &c.—all these have some part to play in the work of construction or in the art of carrying on when construction is completed. Everything in the way of manufactures which goes to making irrigation and other public works complete and operative, just as everything which is indispensable to the growth of the great South African refrigerating industry."

FOREIGN NOTES.

Canton.—The American Consul-General reports that the walls of Canton are about to be removed in order to permit of the construction of a street tramway system.

The "Manchester Guardian" states that these walls are from 6 to 7 miles long, and are estimated to contain 4,200 sq. yds. of bricks, 4,500 sq. yds. of stone and 1,000,000 cubic yds. of earth. There will also have to be demolished about 5,000 houses. The cost of the alteration is to be made partly by a syndicate of Chinese merchants and partly by the local authorities from a foreign loan. The country that furnishes the funds for the enterprise will (it is said) also have the opportunity of supplying the engineers and the equipment.

Chili.—Decrees have been issued granting concessions to the undermentioned persons for the installation, in the places named, of electric lighting and power systems with overhead transmission:—

Leopoldo Chasau (Los Sauces, Dept. of Angol); Rojelio Pinto (San José de Maipo, Dept. of La Victoria); Eduardo Valdivieso Lanco, (Dept. of Valdivia).

The acting British Consul at Santiago also states that the Chilian Senate has sent to the Chamber of Deputies for approval a bill providing for bounties for shipbuilding and the construction of marine machinery.

Norway. The "Tidens Tegn" of Christiania, states that a Norwegian electrical company has, after successful experiments, erected plant for preparing aluminium sulphate from labradorite, a mineral which occurs in Western Norway. The plant is expected to supply the entire Norwegian demand for aluminium sulphate for the paper industry, which has hitherto been imported.

Siam. The engineer of the Siam Electricity Co. (Bankok) reports that his company has a fleet of five electric vehicles, two of which have been in use since 1904.

The thirteen year old vehicles are used for lamp delivery, while the larger trucks are used for various other purposes. The vehicles are operated successfully by unskilled natives and are found to be economical. In place of coal the company uses rice husks and this fuel is obtainable in almost unlimited quantities at small cost. The company keeps an oil tank for reserve fuel, but it is rarely needed.

MISCELLANEOUS.

Birkenhead Strike. The strike of the stokers, engine drivers and trimmers at the electricity works was settled on the 12th inst., when the Wages and Electricity Committees decided to grant the request of the men for a penny per hour advance in their wages.

[illegible]

Dutch Cable Embargo. [illegible]

Leaving Certificates. [illegible] Order of the Minister of Munitions [illegible]

[illegible]

recently appointed to inquire into the position of skilled engineers, has made an Order providing that the following directions shall have effect with respect to the remuneration to be paid to fully qualified skilled engineers and moulders of the class specified for munition work and work in connection therewith which is paid at time rates.

1. Workmen to whom these directions apply shall receive a bonus of 12½ per cent. on their earnings, which shall not alter or become part of their time rates.

2. The bonus payable under these directions shall accrue as from the beginning of the first full pay day following Oct. 12.

3. These directions apply (subject to paragraphs 4 and 5) only to fully-qualified skilled engineers and moulders rated at or above current district time rate for turners or fitters while employed on or in connection with munitions work, and paid at plain time rates without the addition of any bonus other than (*a*) a bonus dependent on timekeeping; (*b*) a bonus (not being a bonus on output) less favourable to such workmen than the bonus payable under these directions in which case the existing bonus shall merge in the bonus payable under these directions; (*c*) a war advance given to meet the cost of living as the result of or in conformity with arbitration under Part 1 of Munitions of War Act, 1915.

4. These directions shall not apply to workmen of the class specified in paragraph 3 whose wages it has been the practice to regulate by the movements in the wages of men employed in trades other than engineering and foundry trades.

5. These directions shall not apply to workmen paid an upstanding wage or salary which covers overtime or other allowances.

6. Nothing in the foregoing provisions shall affect the present basis of determining piece rates or premium bonus times or any other system of payment by results.

7. Any contravention of or non-compliance with these directions is punishable in like manner as if this Order was an award made in settlement of a difference under Part 1 of the Munitions of War Act, 1915.

Metals in Warfare.—At the meeting of the Manchester Association of Engineers on Monday, Mr. J. P. Bedson delivered his presidential address.

Mr. Bedson referred to the phases through which the manufacture of wire has passed until its present perfection was reached, and to its indispensability in the building of bridges, the making of cables, and the production of innumerable other things. The present war had become a "wire war," for it was used from the rivets in the soldiers' boots to the nets which caught the submarines, to say nothing of the barbed wire used in entanglements. Half the wire used in the manufacture of the first Atlantic submarine telegraph cable was made within 600 yards of their place of meeting, and that in the upper story of the mill where the wire was drawn, Dr. Henry Wilde carried on his electrical experiments, in which he demonstrated his ability to melt an iron bar by means of the electric current. From the same place he caused the first rays of an electric searchlight to flash over Great Ancoats.

To-day, Mr. Bedson said, we realised more than ever the importance of iron. In their seizure of Alsace and Lorraine the Germans had secured a vast field of iron ore. Their ambition was to retain those provinces, which contained so much wealth, and also to secure the Briey basin—in the north of France, where even greater deposits of ore occurred. If they were successful, Germany would hold the second position in the world as an iron and steel producing country. Mr. Bedson urged the importance of improved transport facilities, and, in particular, the value of water-carriage. Germany and other Continental nations had long seen the importance of inland waterways.

Price of Coal.—The Board of Trade have increased the price of coal at the pit's mouth by 2s. 6d. a ton to meet the cost of the war wage recently granted to the miners.

Applications made by certain districts for an increase in the "standard amount" under the Price of Coal (Limitation) Act are being examined by the Controller of Coal Mines.

Trading with the Enemy. The "London Gazette" of Oct. 12 contains further additions to the list of firms and persons with whom trading by firms or persons in the United Kingdom is prohibited.

These include:—*Portugal*: Siemens Schuckert Werke Limitada (Rua Augusta 27, Lisbon).

A list of corrections to entries previously published includes: *Argentina, Paraguay* and *Uruguay*: Siemens Schuckert Companies (Calle Bernardo de Irigoyen 330 and Calle Sarmiento 1401, Buenos Ayres).

TENDERS INVITED AND ACCEPTED.

House Service and Fuse Boxes and Fittings.

Grimsby Corporation invite tenders for the supply of house service boxes and fittings and house fuse boxes and fittings. Forms of tender and specification from the deputy electrical engineer, Mr. A. S. Chorlton, and tenders to the Town Clerk, Municipal buildings, Victoria street, Grimsby, by first post, Oct. 29.

Electrical Fittings.

The Great Northern Railway Co. (Ireland) require tenders by 10 a.m. Nov. 1 for [illegible] 12 months' supply of Electric Fittings, Lamps, &c., Cable and Wire, Carbons, &c. Forms of tender from the Secretary, Amiens street, Dublin.

Railway Signalling Apparatus.

The Victorian Railway Commissioners require tenders by 11 a.m., Oct. 31, for the supply of 45 time element relays for power signalling contract 50,989. Specifications from the Commissioners' Offices, Spencer street, Melbourne.

BARROW-IN-FURNESS.—The Council has accepted the following tenders :—

British-Thomson-Houston Co., switchgear, £303 ; Ferranti Limited, switchgear £713 and transformers £369 ; British Insulated & Helsby Cables, cables, £1,718 ; Boiler Tube & Flue Cleaner Co., tube cleaning apparatus, £173.

MANCHESTER.—The Corporation has accepted the following tenders for supplies for the electricity department :—

Callender's Cable & Construction Co., W. T. Henley's Telegraph Works Co., C. Macintosh & Co. and British Insulated & Helsby Cables, cables ; and Ferranti Limited, oil-cooled transformers.

SOUTHEND.—The Council has accepted the following tenders for the tramway undertaking :—

Edgar Allen & Co., switches, crossings and fish plates, £54 ; Hadfields (Ltd.), three pairs of points and three crossings, £237.

APPOINTMENTS VACANT AND FILLED.

A mechanical and electrical engineer is required to take charge of electric lighting plant, boilers, engines, &c. Particulars of duties may be obtained from the Clerk at the Bracebridge District Asylum (Mr. E. B. George), near Lincoln, and applications to the Clerk to the Visitors (Mr. H. E. Page), solicitor, 5 and 6, Bank-street, Lincoln, by the 25th inst. *See advertisement.*

Technical design assistants are required by an electrical firm in the Midlands. *See advertisement.*

A shift engineer is required by a large manufacturing concern under Government control ; also filter driver. *See advertisement.*

An assistant lecturer and demonstrator in electrical engineering is required for Battersea Polytechnic, London, S.W. 1. Salary £200. Particulars from the Secretary.

Mr. A. W. Powell has been appointed assistant engineer in charge at Worcester, at £127 per annum, plus war bonus.

BUSINESS ITEMS.

Mr. W. F. M[illegible] the Carron Co.'s electric cooking and heating department, and who, as an officer of the Highland Light Infantry, was wounded in May, 1916, has [illegible] previous work.

The partnership between Karl F. Schall and W[illegible] Schall, electrical engineers, 71 and 75, New Cavendish street, London, W.C., has been dissolved by the retirement of Karl F. Schall therefrom. Debts by W. F. Schall [illegible]

Mr. Robert A. Smith, consulting engineer, has removed to temporary offices at 14, Victoria-street, S.W. 1.

The [illegible] motors up to 200 [illegible]

Messrs. E. F. P[illegible] London, E.C. 4, notify that they have acquired the rights for France, and the French Colonies of the Wild-Barfield process for hardening steel gauges, tools, &c.

Owing to the great interest taken in the new geared electric starter for motors just introduced by Messrs. C. A. Vandervell & Co., and the wide publicity it has received, the firm have found it impossible to cope with all the demands for booklets, drawings, &c., but inquiries are being dealt with as rapidly as possible.

LIQUIDATIONS.

A meeting of members of [illegible] Co. (Ltd.) (in liq.) will be held at 6, Old Jewry, London, E.C. 2, to receive an account of the winding-up.

An order was made [illegible] Lamps (Ltd.), [illegible]

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Ayr.—The accounts of the electricity supply department for the year ended May 15 show gross capital expenditure £127,274 (increase £3,421), of which £46,420 has been paid off.

Revenue was £17,537, and working expenses were £10,257, leaving gross profit £7,280. Interest required £3,329, and sinking fund £3,899, the balance (£52) being carried to reserve. Total maximum supply demanded was 945 kw. Units generated were 2,114,613, and sold 1,573,733.

The capital expenditure on the tramways is £102,422, of which £27,387 has been repaid. Revenue was £21,074 and working and general expenses were £12,842, leaving gross profit £8,232. Interest, repayment of loans, sinking fund, and depreciation (£2,517) absorbed £8,106, and the surplus was £138.

Barnes.—The receipts of the electric supply undertaking for the quarter ended June 30 were £4,359 and the expenditure £4,870, leaving a deficit of 511, compared with £675 in the corresponding period of 1916.

Hampstead (London).—The accounts of the electricity department for the year ended March 31 show total capital expenditure £485,[illegible] (increase £6,0[illegible]), of which £254,8[illegible] has been repaid, £10,498 written off and £21,731 met out of revenue.

[illegible]

Hove.—[illegible]

Ipswich.—[illegible]

wages in power station [illegible]

for charging [illegible] pality to establ[illegible]

[illegible]

W[illegible]

COMPANIES' MEETINGS AND REPORTS.

EASTERN TELEGRAPH CO. (LTD.)—For the year ended Dec. 31, 1916, the revenue amounted to £2,519,283. 8s. 8d., from which are deducted £707,037. 18s. 7d. for the ordinary expenses, and £352,905. 6s. 9d. for expenditure relating to maintenance of cables, income tax payable abroad and special war payments to staff and other expenses in connection with the war, leaving a balance of £1,459,340. 3s. 4d., to which is added £26,637. 15s. 1d. from the preceding account, making a total available balance of £1,485,977. 18s. 5d. After providing for income tax and excess profits duty payable in England, interest on mortgage debenture stock and dividends on the preference stock, which in all absorb £596,289. 11s. 10d., there remains £889,688. 6s. 7d., out of which the directors have placed £500,000 to general reserve fund, £10,000 to insurance of war risk at stations fund, and £5,000 to insurance of goods in transit fund. Three interim dividends of $1\frac{1}{2}$ per cent. each and a final dividend of $1\frac{1}{2}$ per cent. and a bonus of 2 per cent. have been paid on the ordinary stock, amounting together to £320,000, and making a total distribution of 8 per cent. (tax free) for the year. These appropriations absorb £835,000, and leave £54,688. 6s. 7d. to be carried forward. The general reserve fund has been charged with £11,950. 11s. 3d. in respect of loss on sale and redemption of investments and certain special expenditure, and with £150,000 as a further provision on account of investment fluctuations. After crediting the £500,000 referred to above the net addition to the fund for the year is £338,049. 8s. 9d.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.) The gross receipts for the year ended Dec. 31, 1916, amounted to £1,221,497. 7s. 4d., against £950,029. 19s. 7d. for the previous year. The working expenses, including £74,607. 10s. 10d. for the maintenance of cables, absorbed £430,243. 19s. 6d., against £386,671. 15s. 5d. for the previous year, leaving a balance of £791,253. 7s. 10d., and after adding £38,816. 6s. 1d. brought forward, the available balance was £830,069. 13s. 11d. From this balance £246,852. 18s. was provided for income tax and excess profits duty payable in England, and £30,096 for interest on the mortgage debenture stock, leaving £553,120. 15s. 11d., out of which four dividends of $1\frac{1}{2}$ per cent. each and a bonus of 2 per cent., amounting together to £240,000, were paid, making a total distribution for the year of 8 per cent. (tax free). The balance of £313,120. 15s. 11d. has been disposed of by transferring £250,000 to general reserve fund and carrying forward £63,120. 15s. 11d. The agreement entered into by the French Government with the company in 1884, for providing and maintaining under a subsidy arrangement, cable communication between Cochin China and Tonquin having expired, the cable has been sold and transferred to the Government. After crediting capital expenditure with the cost of the cable (£121,454. 15s. 7d.), which was originally debited to that account, the loss resulting from the transaction, amounting to £66,153. 13s. 9d., has been debited to general reserve fund. Under arrangements made with the Governments of the Australian Commonwealth and New Zealand, the company's cable stations at La Perouse (near Sydney) and Wakapuaka (near Nelson) have been closed, and its cables between Australia and New Zealand extended to Wellington, where they are now being worked direct with Sydney under greatly improved conditions. The cost of the extensions and partial renewals of the cables will be debited to general reserve.

ELECTRIC SUPPLY CO. OF VICTORIA (LTD.)—The directors' report states that the lamps connected at March 31 were 188,402 (against 166,2[illegible] in 1915-16, and 150,132 in 1914-15). The tramways department carried 4,803,895 passengers, against 4,877,325 in 1915-16 and 5,177,368 in 1914-15. The past year's revenue was £88,238 (against £86,080) and the expenditure £[illegible],990 (against £55,378), leaving a balance of £29,[illegible]28, making with amount brought forward (£6,433), £35,961. Deducting debenture interest (£7,392) and amount for debenture stock redemption (£6,892), the balance is £21,677. The directors propose to pay on account of arrears of preference dividend £5,250 and to carry forward £16,427.

LLANGEFNI ELECTRIC LIGHT & POWER CO. (LTD.) The net profit for the past year was only £12, owing to the great increase in the cost of fuel and materials, and an endeavour has been made to organise the [illegible] of the station so as to use the available water power to the fullest extent. The directors have discontinued the supply on the [illegible] system, and the substitution of meters for the [illegible] system has [illegible] in the units used.

MONTREAL TRAMWAYS CO. For the year ended June 30, the gross passenger earnings increased by 11.45 per cent. over last year, but operating expenses increased 24.14 per cent. The ratio of operating expenses to gross earnings was 62.40 per cent., against 57.93 per cent. The sum of $[illegible] has been charged to contingent renewal account [illegible] with $313,770 [illegible] has been expended for maintenance of property [illegible] charged to operating expenses, making a total expended for upkeep $1,[illegible],931 against $8[illegible],170 last year. The [illegible] and operating expenses $1,691,772, [illegible] $[illegible]. After deducting bond and loan interest [illegible] debenture stock, $800,000 contingent account [illegible] and [illegible] tax $110,000, the surplus balance was $[illegible].

NATIONAL TELEWRITER CO. (LTD.) The report for the year to [illegible] states that the [illegible] operated owing to the [illegible] shows a loss of £[illegible], compared with [illegible]

PORTARLINGTON ELECTRIC LIGHT & POWER CO. (LTD.)—The gross revenue for the year ended June 30 was £693, against £651 for the previous year. The expenditure increased from £484 to £552, due mainly to a regrettable breakdown of the engine, which caused the closing down of the generating station for 13 days. The net profit was £141 and the amount to credit of profit and loss account was £320. The directors recommend payment of a dividend of 5 per cent. on the preference shares, which will absorb £128.

NEW COMPANIES, MORTGAGES AND CHARGES.

NEW COMPANIES.

BERNARD, NICKLIN & CO. (LTD.) (148,566).—Private company. Reg. Sept. 28, capital £10,000 in £1 shares, manufacturers of and dealers in iron, steel, copper, &c., electricians, mechanical, electrical and general engineers and contractors, chemical manufacturers, boiler makers, &c.

CORONA LAMPWORKS (IRELAND) (LTD.) (4,498.)—Private company, reg. in Dublin, Oct. 3, capital £6,000 in £1 shares, manufacturers of and dealers in all kinds of electric bulbs, lamp fittings, &c. Agreement with the Corona Lampworks (Ltd.). First directors are Geo. N. Ogilvie, W. Hepworth-Collins and C. Shields. Secretary, C. Shields.

GROSVENOR ENGINEERING WORKS (LTD.) (148,632).—Private company, reg. Oct. 8, capital £2,000 in £1 shares (1,900 7 per cent. cumulative preference), to carry on the business of electrical engineers and contractors, makers of and dealers in aeroplanes, aircraft and components, &c. First directors are R. P. Murray and A. E. Morgan. Secretary, C. Sutton. Reg. office: Poole Hill, Bournemouth.

MORTGAGES AND CHARGES.

CLEVEDON, PORTISHEAD & DISTRICT ELECTRIC SUPPLY CO. (LTD.)—Particulars of £5,000 debentures created Aug. 14, 1917, have been filed, the whole amount being now issued. Property charged: Company's undertaking and property, present and future. No trustees.

LLANGOLLEN & DISTRICT ELECTRIC LIGHT & POWER CO. (LTD.)—Debenture dated Sept. 20, 1917, to secure £200, charged on company's undertaking and property, present and future. Holders: T. O. Ockleston and H. Wilson.

ROTABLE ELECTRIC CO. (LTD.)—Particulars of £2,000 debentures created Sept. 14, 1917, have been filed, whole amount being now issued. Property charged: Company's property, present and future. No trustees.

CITY NOTES.

CALCUTTA TRAMWAYS CO. (LTD.)—An interim dividend at the rate of $2\frac{1}{2}$ per cent. per annum has been declared on the ordinary shares.

CITY OF SANTOS IMPROVEMENTS CO. (LTD.)—A half-yearly dividend at rate of 6 per cent. per annum (less tax) has been declared on the preference shares.

COMPANIES TO BE STRUCK OFF THE REGISTER.—The following will be struck off the register of Joint Stock Companies, unless cause to the contrary is shown before Dec. 28: Cleartone Antiseptic Telephone Drum, Electrolysers, Electromechanical Co., Tyrone Power Co., Universal Electrical Contracts.

The following will be struck off the Register of Joint Stock Companies, unless cause to the contrary is shown before Dec. 25:—

Eastern Electric Co., Electrical Engineering & Motor Co. (Carlisle), Transport Development and Power Synd., Vanadium, X.L. Electric Co.

The following will be struck off unless cause to the contrary is shown before Jan. 2: Acton Battery Co., Electrical Sales Promotion, Hydrocarbon Research Co., London Battery and Mfg. Co., Mies Electrical and Chemical Culture, Photo-Telegraph & Cable Co., United Cablegram Co. of France.

EASTERN TELEGRAPH CO. (LTD.) The company announce the payment by warrants on Nov. 1 of interest for the half year ending Oct. 31 on their 4 per cent. mortgage debenture stock. The transfer books of the debenture stock will be closed from the 26th to the 31st inst. inclusive.

LANCASHIRE DYNAMO & MOTOR CO. (LTD.)—A dividend of 5 per cent. has been declared on the ordinary shares (tax free).

ORIENTAL TELEPHONE & ELECTRIC CO. (LTD.)—The directors have declared the following dividends: 3 per cent. on the 6 per cent. cumulative preference shares for the current year (less tax), and 4 per cent. on the ordinary shares (tax free).

RIO DE JANEIRO TRAMWAY, LIGHT & POWER CO. (LTD.)—A quarterly dividend of $1\frac{1}{4}$ per cent. has been declared.

SAO PAULO TRAMWAY, LIGHT & POWER CO. (LTD.)—A dividend of $2\frac{1}{2}$ per cent. has been declared.

SHANGHAI ELECTRIC CONSTRUCTION CO. (LTD.)—An interim dividend at the rate of 5 per cent. per annum, less tax, has been declared.

SHAWINIGAN WATER & POWER CO.—A dividend of $1\frac{1}{4}$ per cent. has been declared for the quarter ended Sept. 30.

UNITED RIVER PLATE TELEPHONE CO. (LTD.)—The directors have declared an interim dividend of 3 per cent. (3s. per share) on the ordinary shares (tax free) for the half year ended June 30.

THE ROUND TABLE.

By "KVA."

Event of the Week.—Mr. Herbert H. Berry discloses the parentage of the Cable Makers' Association. ("It's a wise child," &c.)

* * * *

Cause and Result ?—The Borough Electrical Engineer of Rotherham recommends his committee to install a 25,000 kw. turbo-generator. The committee recommends that the salary of the Borough Electrical Engineer be increased by £100 per annum ; 0·08 shilling per kilowatt rise !

* * * *

It has been decided that iron money shall be issued in Denmark. What a chance for the magnetic pick-pocket !

* * * *

A wasps' nest has been discovered in a gas meter in Manchester. The majority of us are satisfied with a meter with one sting, but a meter with a whole nestful. Gee !

* * * *

Manchester has licensed its first gas-driven taxi-cab. If somebody drops a nice red-hot cigar end from the top of an electric tram, the result will be due to the fusing of electric wires I suppose.

* * * *

Two further incidents of the recent moonlight raids are worth recording. A well-known electrical man arrived at one of the main termini while a barrage was in progress, and could get no taxi to take him to his hotel. He set out to walk with a heavy bag, but found it warm work. Being a man of resource he hailed the only vehicle passing, which happened to be an empty laundry van, horse drawn. He was taken aboard, had an interesting chat with the driver about the war and raids in general, and drew up at his hotel (quite a swell caravanserai) in this unique equipage !

* * * *

THIRTY-SEVEN YEARS AGO.

[From The Electrician, October 16, 1880.]

WHAT IS ELECTRICITY ?

To the Editor of The Electrician.

Sir,—Mr. Johnstone, in your last issue, credits me with a great deal more knowledge than I either possess or hope to possess for many years to come.

If I knew in which direction the current of electricity flows, I should have no need to ask, "What is electricity ?" I do not even know whether the flow [illegible] direction at all.

When one end of the [illegible] connected to a source of electricity, and positive electricity appears at the other end, it is a common convention to say that "Negative electricity has travelled along the wire from the source."

If Sir Mr. Johnstone likes to deposit his £50 in your hands with a request to [illegible] you [illegible] positive electricity flows from the [illegible] the earth [illegible] further, if I should be so fortunate [illegible] [illegible]

[illegible]

J. E. H.

American Nitrate Plants.—[illegible] printed \$20,000,000 [illegible] tions and fertilisers [illegible] in building a similar [illegible] process of the [illegible] 10,000 lb. of [illegible]

[illegible]

Electric Vehicles in New Zealand.—[illegible]

Electricity in Tin Mining.—[illegible] water from the Ouree River, which was inside their own property, and [illegible]

At the [illegible] W. A. [illegible] power station. It was over three years since the station was closed down, and [illegible] consideration. Accordingly they agreed to enter into negotiations [illegible]

Electric Railways in Ontario.—[illegible] along the [illegible] great [illegible] facilities offered by the local electric railway.

[illegible]

Water Power in Italy.—[illegible]

GOOD LIGHTING FOR RETAIL STORES.

Just as in a factory or workshop, adequate and suitable illumination increases the output and raises its quality, so in a well lighted store the turnover is increased and the business of buying and selling made more attractive and less arduous, while the overall cost of the better illumination secured is no greater and is often materially less.

No better example of scientific modern shop-lighting could be advanced than that afforded by the installation at Messrs. Hammonds, Ltd., of Hull, whose well-known department stores have lately been equipped throughout with Mazda half-watt type lamps in conjunction with semi-indirect and indirect lighting fittings. Illustrations are given of two departments of the stores, which are representative of all throughout the firm's extensive premises. These illustrations have been reproduced from untouched photo-

graphs taken by the unaided light of the fittings installed, and although the lighting is uniform and adequate, the wattage absorbed is substantially less than would have been necessary to obtain the same illumination on every article by direct lighting.

In Fig. 1 is shown a portion of the ironmongery department, which is lighted by ceiling type semi-indirect "Lumina" fittings with half-watt type Mazda lamps. These fittings have been designed specially for use in business premises, and comprise a perforated spun copper canopy at the top, the interior of which is so arranged that the heat from the lamp below passes away through the holes and does not affect the ceiling. It is provided with a vitreous enamelled over reflector and a 15 in. special opal glass bowl which conceals a 200 watt half-watt type lamp. It will be seen that the intensity of the illumination is uniform throughout the department, and that although, as is desirable, a certain amount of

shadow exists, there are no violent contrasts between light and shade as would be the case with direct lighting.

A better idea, perhaps, of the excellence of the lighting throughout the building is afforded by the second illustration, which shows the linoleum department. The almost startling clearness of the detail (such as the patterns on the rolls of linoleum) is not confined to individual objects, but applies to every item in the display. This effect is produced by semi-indirect "Lumina" ceiling fittings and Mazda half watts, as employed in the ironmongery, hardware and other departments. The whole of the lighting scheme for Messrs. Hammonds was planned, and the fittings and lamps supplied, by the British Thomson Houston Co., Ltd., Mazda House, 77, Upper Thames street, London, E.C. 4.

ALIEN ENEMY PATENTS IN THE U.S.A.

The American Trading with the Enemy Act contains a number of clauses relating to patents and for the purpose of comparison with our own legislation on the subject, we reproduce the most important of them.

(*a*) An enemy or ally of enemy may file and prosecute in the United States an application for letters patent, or for registration of trade mark, print, label or copyright, and may pay any fees therefor in accordance with and as required by the provisions of existing law. Any such enemy or ally of enemy who is unable during war or within six months thereafter, on account of conditions arising out of war, to file any such application, or to pay any official fee, or to take any action required by law within the prescribed period, may be granted an extension of nine months beyond the expiration of said period, provided the nation of which the said applicant is a citizen, subject or corporation shall extend substantially similar privileges to citizens and corporations of the United States.

(*b*) Any citizen of the United States, or any corporation organised within the United States, may pay to an enemy or ally of enemy any tax, annuity or fee which may be required by the laws of such enemy or ally of enemy nation in relation to patents and trade-marks, prints, labels and copyrights; and any such citizen or corporation may file and prosecute an application for letters patent or for registration of trade-mark, print, label or copyright in the country of an enemy or of an ally of enemy after first submitting such application to the Secretary of Commerce and receiving licence so to file and prosecute.

(*c*) Any citizen of the United States, or any corporation organised within the United States, who desires to manufacture or cause to be manufactured a machine, manufacture, composition of matter, or design, or to carry on or cause to be carried on a process under any patent or copyrighted matter owned or controlled by an enemy or ally of enemy at any time during the existence of a state of war, may apply to the Federal Trade Commission for a licence; and said commission is hereby authorised to grant such a licence, non-exclusive or exclusive as it shall deem best, provided it shall be of the opinion that such grant is for the public welfare, and that the applicant is able and intends in good faith to manufacture or cause to be manufactured the machine, manufacture, composition of matter, or design, to carry on or cause to be carried on the process or to use the copyrighted matter. The Federal Trade Commission may prescribe the conditions of this licence and the rules and regulations under which it may be granted and the fee which shall be charged therefor, not exceeding $100, and not exceeding 1 per centum of the fund deposited as hereinafter provided.

(*d*) The licensee shall file with the Federal Trade Commission a full statement of the extent of the use and enjoyment of the licence, in such form and at such stated periods (as least annually) as the commission may prescribe; and the licencee shall pay at such times as may be required to the alien property custodian (or to such other officer as the President shall direct) not to exceed 5 per centum of the gross sums received by the licencee from the sale of said inventions or use of the copyrighted matter, or, if such commission shall so order, 5 per centum of the value of the use of such inventions or copyrighted matter to the licencee as established by the Federal Trade Commission; and sums so paid shall be deposited by said alien property custodian (or by such other officer as the President shall direct) forthwith in the Treasury of the United States as a trust fund for the said licencee and for the owner of the said patent or copyright registration.

(*e*) Unless surrendered or terminated as provided in this act, any licence granted hereunder shall continue during the term fixed in the licence, or, in the absence of any such limitation, during the term of the patent or copyright registration under which it is granted. Upon violation by the licencee of any of the provisions of this act or of the conditions of the licence, the Federal Trade Commission may, after due notice and hearing, cancel any licence granted by it.

(*f*) The owner of any patent or copyright under which a licence is granted hereunder may, after the end of the war and until the expiration of the year thereafter, file a bill in equity against the licencee in the District Court of the United States for the district in which the said licencee resides, or, if a corporation, in which it has its principal place of business (to which suit the Treasurer of the United States shall be made a party), for recovery from the said licencee for all use and enjoyment of the said patented invention or copyrighted matter; provided, however, that whenever suit is brought as above notice shall be filed with the alien property custodian (or with such other officer as the President shall direct) within 30 days after date of entry of suit; provided further, that the licencee may make any and all defences which would be available were no licence granted. The court on due proceedings had may adjudge and decree to the said owner payment of a reasonable royalty.

(*g*) Any enemy or ally of enemy may institute and prosecute suits in equity against any person other than a licencee under this act to enjoin infringement of letters patent and copyrights in the United States owned or controlled by said enemy or ally of enemy, in the same manner and to the extent that he would be entitled so to do if the United States were not at war.

(*h*) Except as provided in this section, nothing in this act shall be construed to authorise the prosecution or maintenance of any suit or action at law or in equity by an enemy or ally of enemy in any court within the United States prior to the end of the war; provided, however, that an enemy or ally of enemy may defend by counsel any suit in equity or action at law which may be brought against him.

PATENTS AND TRADE MARKS IN JAPAN.

A bill dealing with the law relating to industrial property in war time was recently introduced into the Japanese Imperial Diet by the Minister of Agriculture and Commerce and was passed without amendment.

The new law provides that in respect to applications or demands of enemy subjects relating to industrial property, patents or registrations shall be suspended during the war. Should an invention, design or model under an application or demand be one which during the war has been publicly known or publicly used in the Empire, or one which during the war has been described in a publication circulating in the Empire in such a manner as to enable it to be easily put into practice, no patent is to be granted nor registration made. The law also provides that during the war no enemy subject may make a demand for trial or appeal trial in respect of industrial property, or bring any action against a judgment in appeal trial. Provision is made in the law for cancellation during the war of patents or registrations of trade marks belonging to enemy subjects, and it is also provided that such cancelled patented inventions may be exclusively used by persons obtaining permission to do so.

THE COPPER SITUATION IN AMERICA.

In a recent issue of the "Wall Street Journal" there is a review of the situation created by the shortage of copper, and it is stated that about 65 per cent. of the nation's supply of copper, exclusive of that used for military purposes, is absorbed by public service industries.

Our contemporary says: "While wire is the form most required, telegraph, telephone and electric light companies, though without appreciable reserves, are able to defer their necessities. New consumption is usually for extensions and the wiring of new districts, but these can wait. The shortage will be felt most in the use of overhead trolly wire, not only for municipal and suburban service, but for inter-urban systems.

"Factories are running at full capacity, but their product is for warfare. Not only are there 30 or more new fourth-class cities, termed encampments, to be fully equipped with electric light and telephone, but the field telephone and telegraph wire requirements for the armies in America and France are enormous. The needs of the Navy include, not only light and telephone wire, but immense quantities of copper wire are prepared for purposes unfamiliar to the layman, as, for instance, the exploding of mines. Much of the wire used by the Government is cable of extra flexibility, and the manufacture of its strands, involving drawing the finest gauges, materially lessens the tonnage capacity of the factories.

"That the foreign demand on American industry has been less for months than previously is due to the necessities of the United States incident to her entrance into the war. Orders for brass and for copper in sheet and wire form, in huge amounts, to be used by the Allies, are now seeking placement for the earliest delivery possible, and the inference is unavoidable that the copper factories of the nation will continue to be largely employed, if not monopolised, for the production of war necessities until peace is declared.

"When the copper industry reverts to normal channels, the ease with which domestic consumption may obtain its full requirement will still be uncertain. A leading representative of the trade declares that until the elimination of European copper products from all but the field of war, American industry utterly failed to realise the magnitude of the commercial world. Nagged and fairly goaded into adaptation to the South American trade, Europe was neglected and Asia practically unknown. The American copper trade has now acquired a substantial foothold in the Antipodes. China, Java, and Russia have become fields of American commercial activity, important and potentially unlimited. It is not to be assumed that, with the advent of peace, our producers and manufacturers will neglect to maintain their recent expansion."

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

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CONTENTS.

NOTES.

Fixation of Nitrogen in the U.S.A.

As in other countries, the production of nitric acid and other forms of combined nitrogen became important in the United States as soon as there was a prospect of war, and in characteristic fashion the situation was handled with vigour by our American cousins. So large a sum as £1,000,000 was voted by Congress to render the position satisfactory—even before a programme was defined—which will astonish slow movers [illegible] by its magnitude. Reports have now been published which will be found in [illegible] on another page, including one of considerable length by Mr. [illegible] Parsons, chief chemist of the Bureau of Mines. As a result of a visit to various European countries, Mr. Parsons reached a number of conclusions. [illegible] of the opinion that the arc process is the cheapest for the production of nitric acid, provided that power can be obtained at [illegible] per horse-power year or less. As is well known, the arc process is the only one which gives nitric acid directly. All the [illegible] are simply methods for producing ammonia, which must then be oxidised to nitric acid. Thus, in the [illegible] is obtained. It is, therefore, [illegible]

The Recommendations.

[illegible]

[illegible] in terms of [illegible] by-product [illegible] and, if [illegible] synthetic production of ammonia by a modification of the Haber process [illegible]. It is on these lines that the United States [illegible]. In [illegible] it must be remembered that the conditions created by war are entirely artificial and what may be necessary for war purposes would be impracticable or commercially unsound for conditions of peace. Much depends also upon the product that is required. Nitric acid is not the only material necessary for warfare; other forms of combined nitrogen, such as ammonium nitrate, are equally valuable. It must also be remembered that the conditions are not the same in all countries. The conditions in this country differ very materially from those in the United States. It does not follow, therefore, that in this country we can depend merely on by-product ammonia for the production of nitric acid, and equally it may well be that a cyanamide scheme is desirable here, and even an arc scheme, in order that our national needs should be sufficiently met. The arc process is inefficient in the extreme, but this very fact means that only a small improvement in absolute efficiency might cause a material change in the commercial possibilities.

The New Labour Party.

Our readers will have noticed that the National Executive of the Labour Party has proposed a [illegible] so as to place the Party [illegible]. With the purely political aspects of the matter we are not concerned, but there is one change to which we would direct attention. The Party is in future to be thrown open [illegible] [illegible] and we have always felt [illegible] to find that the wid[illegible] country.

Industrial Councils.

[illegible] carried [illegible]

Capital. There is need for education of both Capital and Labour so that the employers may sympathetically understand the claims of Labour and that employees may understand the difficulties of the employer. Let both parties get together. There must emphatically be education on both sides before any solid progress can be made, and this education must precede the formation of Industrial Councils if these are to prove in any way effective. We therefore suggest that it is time for both trade associations and trade unions to get to work with a view to the interchange of opinions. In this connection we feel that the Industrial League may do most valuable work in bringing both sides together, not so much formally as informally and individually. The less formal such meetings are made the better under present conditions, for frankness, which is most desirable, will then be a greater feature of the proceedings.

The Lighting of Cinema Theatres.

A Report recently issued by the Cinema Commission of Enquiry refers, among other matters, to the lighting of cinema theatres. In a special section devoted to "Lighting and Eye-strain" the evidence given before the Commission by Mr. L. Gaster and Mr. N. Bishop Harman is discussed in some detail, and a few succinct recommendations on this point are made. It is suggested, for example, that there should be adequate lighting of the theatre while the film is being shown. There appears to be general agreement that a low order of general diffused illumination in the auditorium would, if judiciously applied, not interfere with the exhibition of pictures. It would, on the other hand, be useful in removing the tendency to glare due to the extreme contrast between the brightly illuminated screen and the adjacent obscurity. It is further suggested that the best relative illumination of the screen and hall should be determined by a small Committee, consisting of a few members of the Commission and of the Illuminating Engineering Society. Other suggestions are that the duration of the display of films should be limited, intervals of music being provided for the recuperation of the eye, and that the front seats should be removed at least 20 ft. from the screen. When one considers the peculiar conditions to which the eye is subjected in a cinema display, and the fact that it is a form of entertainment very frequently patronised by children, the need for supervision of the lighting conditions is evident. It is mentioned in the Report that the attendances in this country per annum exceed 1,000,000,000. This affords confirmatory evidence that many children in cities visit the cinematograph theatres several times a week. The effect of such displays on their mind, physique and eyesight, therefore, deserves serious consideration.

The Lag in Wireless Time Signals.—Some experiments were recently conducted by Mr. F. D. Ome of the United States Naval Observatory on the lag in wireless time signals between Arlington and Great Lakes station. The lag was found to be approximately 0·085 sec. with a probable error of 0·002.

Institution of Engineers and Shipbuilders in Scotland. The opening meeting of the session of the above Institution was held at the Royal Technical College, Glasgow, on October 23rd, when Mr. W. H. Riddlesworth, M.Sc., delivered his presidential address. An attractive series of Papers has been arranged, including one on "Electrical Propulsion of Ships," by Mr. W. B. Hird.

Uses of Uranium Steel.—According to the "Iron Age," the production of ferro-uranium obtained as a by-product in the extraction of radium is to be studied experimentally by the Bureau of Mines in the United States. Ferro-uranium, it is stated, is largely used for making uranium steel which has been employed in Germany for the lining of big guns. The work will involve the use of electric furnaces, and tests of a series of samples of these special steels will be conducted by the Bureau of Ordnance.

Electric Wiring in American Military Camps.—Some idea of the elaborate measures that are being taken for the equipment of some of the military camps now being established in the United States may be gathered from the particulars published in the "Electrical Review" (U.S.A.) relative to the Camp Travis Army Cantonment (Texas). It is stated that about 275 miles of copper wire will be required, largely for overhead outside equipment. For interior purposes about 22,000 electric lamps, 11,000 porcelain receptacles, 11,000 rosettes and upwards of a million feet of wire have been specified, power being furnished by the San Antonio Gas and Electric Co.

Interconnection in Lancashire and Cheshire.—A meeting of Group "C," of the Lancashire and Cheshire Electric Undertakings, was held at Stalybridge on the 11th inst., at which representatives from the Boroughs of Ashton-under-Lyne, Oldham and Stockport, the Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board and the Glossop Electric Lighting Co. were present. The second report of the Committee of Engineers was fully considered, and it was unanimously resolved:—

1. That this conference of the representatives of the undertakings in group "C" is generally in agreement with the proposals for the "linking up" of the electricity undertakings in the Lancashire and Cheshire area.

2. That this conference of the representatives of the undertakings in group "C" disagree with the portion of the second report as to the conferment of additional powers upon a proposed Joint Board in regard to the establishment and control of all future and existing powers stations and high-pressure transmission lines.

Transcontinental Railways.—The completion of the great railway connecting the east and west of Australia is an important connecting link which should have important influence on the future of this country. It forms one of a number of great railway projects which have impressed the public imagination during recent years, other instances being the Cape to Cairo scheme and the now famous Berlin to Bagdad route. It is stated that America has in view an equally ambitious project—namely, a great Pan-American railway to connect Canada with the Straits of Magellan. The matter was discussed at a conference nearly 30 years ago. Appreciable progress has been made since that date, about 10,000 miles of track having already been linked up. The gaps remaining to be bridged are situated chiefly in Central America. It is hoped that before many years have past passengers will be able to travel by train the whole distance from British Columbia to Cape Horn, a distance of about 16,000 miles.

Flow of Water Through Submerged Pipes.—An investigation has just been completed by the Engineering Experiment Station, University of Illinois (U.S.A.), on the effects of mouthpieces on the flow of water through a submerged short pipe, a matter of considerable interest in relation to hydraulic problems. It is suggested that by giving attention to the shape and angle of connections and intakes, the flow through suction and discharge pipes of low head pumps, and through large valves and sluiceways of dams, culverts, &c., may be considerably increased. Losses of head due to contraction or expansion of the stream may have a considerable influence on subsequent losses, because of the turbulent motion started by such contraction or expansion. Experiments were conducted on a cast-iron pipe 22½ in. long and 6 in. in diameter, bored to a smooth surface and fitted with cast-iron conical mouthpieces of different lengths and angles. The results of the investigation are discussed in Bulletin 96 of the Engineering Experiment Station, free copies of which may be obtained on application to the Director, Urbana, Illinois, U.S.A.

Magnetic and Thermomagnetic Properties of Various Alloys.—Recent reports of the Alloys Research Institute, of the Tohoku University in Japan, contain particulars of several researches on the magnetic and thermomagnetic properties of several alloys and carbides, a synopsis of which

appears in a recent issue of "Nature." Messrs. Honda & Ishiwara describe the results of tests on the magnetic properties of manganese-antimony alloys in a field of about 500 gauss. Manganese is paramagnetic, and antimony diamagnetic, but their compounds, Mn_3Sb_2 and Mn_2Sb, are both ferromagnetic, with a critical temperature at 315°C. Magnetisation at different high temperatures was also measured. This gives important data with regard to the structure of the alloys. Data with regard to the thermomagnetic properties of the carbides found in steels are published by Messrs. Honda & Murakami. They find that iron cementite is ferromagnetic, the specific magnetisation of which in a field of 500 gauss is 19·7. Its critical temperature is 215°C. In the free state it is almost wholly decomposed into its components by heating it sufficiently long at 900°C. The double carbide of iron and tungsten found in low tungsten steels is also ferromagnetic, and its specific magnetisation in a field of 500 gauss is 15·5. Its critical temperature is 400°C, and in the free state it is decomposed on heating to 850°C.

Illumination and the Architect.—An article in the "Architectural Review" points out the need for fuller consideration of artificial illumination on the part of the architect. The design of many buildings is determined to a great extent by the admission of daylight. The sizes of school class rooms, for example, are mainly adjusted to meet requirements regarding the illumination of the desks, and the principle of obtaining maximum window space is now always followed. Similarly, the high and relatively narrow shape of factories is intended to enable abundant light to be obtained from windows on both sides of the building. But in the present day, when artificial light plays such a great part in relation to the use made of an interior by night, the desirability of adapting their design to the artificial lighting should also be borne in mind. A large number of buildings (concert rooms, public halls, &c.) are used quite as much by night as by day, and others (theatres and cinema halls) are used almost exclusively by night. In such cases the architectural design and the illumination should be worked out simultaneously. If mouldings, recesses, alcoves, &c., were designed with a view to providing appropriate receptacles for lamps and fixtures, the lighting appliances could be made much more unobtrusive than at present, and the illumination would become an integral part of the general scheme of decoration, adding to its beauty. At present the artificial lighting of buildings is too often treated with indifference and fittings of an incongruous or unsightly character are grafted on to the decorative scheme when the latter is completely finished.

Magneto Machines for Pocket Torches.—A recent issue of the "Elektrotechnische Zeitschrift" gives some fuller particulars of a new type of pocket torch being developed in Germany and Austria, in which the lamp is supplied with current from a small hand-driven magneto. The shortage of [illegible] to the manufacture of dry cells [illegible] for public use, and this [illegible] to utilise a hand-driven source of current for pocket lamps of various kinds. [illegible] than the ordinary variety, but they have the advantage of not requiring [illegible]. One of the types described [illegible] Budapest [illegible] on the release of energy from a spring [illegible] by the pressure of the thumb on a lever. The whole arrangement weighs about [illegible], and it is contained that the release of the spring [illegible] electric energy to keep the lamp alight for three minutes. [illegible] a heavier machine, weighing about [illegible] to be worked with both hands, has been designed. [illegible] [illegible] [illegible] A somewhat similar apparatus, weighing about [illegible], is designed to [illegible] [illegible] appears to be based on [illegible] of spiral springs, which, having been wound up, [illegible] current for a limited period of time without further [illegible] necessary. If [illegible] magneto is utilised, then application of this principle to portable electric lamps is quite simple and practicable.

Diesel Engine Users' Association.—At the October meeting [illegible] writers and the policy holders as to the [illegible] policy may be submitted for decision to a special [illegible] appointed by the Association.

[illegible] the railways, and which would have produced about 500 tons of clinker and ashes, for which cartage facilities would have [illegible].

Mr. H. S. R[illegible] of Blast Furnace Gas Diesel Engines [illegible]

OBITUARY.

Deaths on Active Service.—The following deaths are reported:—

Capt. Desmond G. T[illegible] [illegible]

PERSONAL

[illegible] of Kentucky, Ill[illegible]

ARRANGEMENTS FOR THE WEEK.

FRIDAY, O[illegible]

[illegible]

TUESDAY, [illegible]

[illegible]

INTERNAL RELATIONS IN AUDION-TYPE RADIO RECEIVERS *

BY RALPH BOWN PH.D.

Summary.—Experimental curves are shown from which the details of the operation of the audion as a detector in radio telegraphy are followed. A theory of the action of the gas in the bulb is presented to explain the curves. Some of the peculiar features of the operation as influenced by the nature and pressure of the gas, magnetic fields, the circuits employed, &c., are discussed in their relation to the theory and the experimental data.

The audion-type radio detector consists of an evacuated glass bulb containing three electrodes: an electron-emitting hot cathode which is commonly a tungsten filament, a cold metal plate placed near the cathode and held at a considerable positive potential with respect to it, and, interposed between these two, a grid or lattice of metal wires. The device is well known as a detector in radio-telegraphy or as an amplifier of electrical impulses such as telephonic currents. Many of its peculiarities and operating features have been fully explained, but others have not been satisfactorily treated and ascribed merely to the irregularities of the conduction of electricity through gases. The writer has devoted considerable attention to the effect of the gas in the ordinary audion type bulb and the object of the present Paper is to give some of his results and conclusions.

THEORY OF OPERATION.

In the ordinary wireless receiving outfit the circuit used is the one illustrated in Fig. 1. It consists of three parts which have a

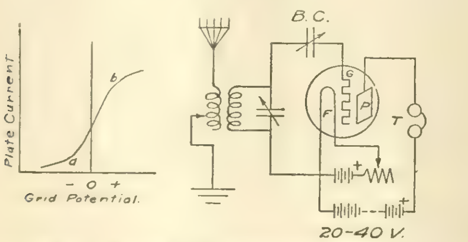


FIG. 1. ORDINARY AUDION RADIO RECEIVER.
F, filament; *G*, grid; *P*, plate; *B.C.*, blocking condenser; *T*, telephone receivers. *a*, *b*, operating curve.

common point at the negative end of the filament. These three circuits are: the filament with its heating battery and regulating rheostat; the plate, in series with the telephone receivers and the high-tension adjustable battery; and the grid in series with its blocking condenser, *BC*, and the tuned oscillating circuit coupled to [illegible]

The current of electrons from the hot filament to the plate depends upon the electrostatic potential of the grid in the manner shown by the curve in Fig. 1, and on this as a basis the operation of the device [illegible] frequency oscillations has been commonly explained in the following manner. Due to the unilateral conductivity [illegible] cold electrode, the incoming oscilla- [illegible] between the grid and the filament and accumulate [illegible] on the grid and the connected plate of the blocking [illegible] of the grid potential causes a correspond- [illegible] in the plate current as indicated by the curve. The dying out of the oscillations allows the charge on the grid to leak off [illegible] normal value. [illegible]

[illegible]

* [illegible]

voltmeter and ammeter, were identical with those in Fig. 1. In the grid circuit were placed an ammeter, a potentiometer with switches to cut it in and out and a voltmeter to measure the setting, a blocking condenser (*BC*) with a short-circuiting switch, and a tuned oscillating circuit, also with a short-circuiting switch, for receiving signals from the buzzer and automatic telegraph sender in the artificial antenna circuit to which it is coupled and tuned. With this arrangement a detector could be adjusted to the best operating condition on actual signals, either with the potentiometer cut out and the blocking condenser in or *vice versa*. Then, with the blocking condenser short-circuited, the potentiometer in and with the tuned circuit either receiving signals or cut out, just as was desired, the curves of grid potential against plate current and grid current could be observed.

The observations made show the truth of the ordinary explanation of the audion working with a blocking condenser, throw some new light on the operation without the blocking condenser and furnish a basis for a theory of the internal relations in the bulb. In the curves, values of current above the zero current line mean negative electrons flowing to the cold electrode in question (*i.e.*, grid or plate) while the values below the zero current line mean positive ions flowing to the cold electrode. The potential of the common point at the negative end of the filament is assumed as zero and the grid and the plate voltages are measured from it. The upper curves show the relation between grid potential and grid current and the lower curves show the simultaneous relation between grid potential and plate current. The voltages labelled on the curves refer to the plate. Some typical diagrams are reproduced in Figs. 3 and 4. The real key to understanding the action of the audion lies not in the plate current curve but in the grid current curve and upon it the following explanations are largely based. The characteristic relations for two points of best adjustment as a detector are given in Fig. 3. That Fig. 3 is really a typical case, and that remarks made about it will apply to any similar detector may be seen by comparison with Fig. 4, which is a composite plot of comparable curves taken at random from a large number of audion type detectors of many different makes and shapes, including some experimental bulbs of exceptional dimensions. The curves of Fig. 4 are all of similar shape and character, and in the light of remarks to follow will be seen to be governed by the same considerations.

It is apparent from Fig. 3 that positive ions exist in the bulb and

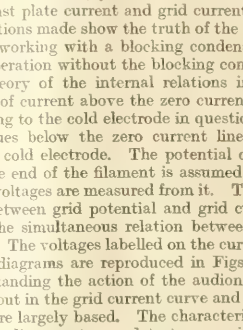


FIG. 2.—TEST CIRCUIT.

that some [illegible] are drawn to the grid, since the grid current [illegible] below the zero current line. When the blocking condenser is in [illegible] the grid-current no current can flow through it and so the [illegible] the potential at which the grid current becomes zero. [illegible] on the plate current curves indicate the [illegible] when the blocking condenser was in, and, on comparison with the grid current at the same ordinates, will be seen to substantiate the above statement. When a group of voltage oscillations is impressed on the grid, the negative ions collected by it on the positive half waves far outnumber the positive ions collected on the negative half waves. The grid acquires a preponderance of negative charges, assumes a more negative potential, backing off to the left on its [illegible] and at the same time causing a reduction in the

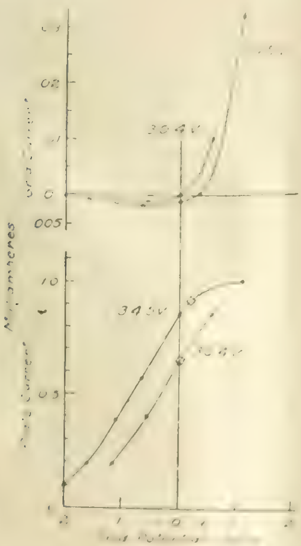
plate current. When the group of oscillations is passed, the grid is left at a potential where it is drawing a positive charge, which neutralises the former condition. The grid potential moves back to the position of zero current, thereby allowing the plate current to increase to normal. The curves show in detail just how this action takes place.

The author has never been able to make an audion work at all well on the lower bend of the plate current curve and so has eliminated this from consideration. It was found, however, that good operation without the blocking condenser could be had not only on the upper bend but in the straight portion of the curve as well. In fact, in many cases a detector would operate equally well on the straight part of the curve irrespective of whether or not a blocking condenser was used and occasionally better without.

Two experimental facts lead to the conclusion that the bend in the plate current curve is a very minor factor. The first is that the operation is not dependent on this bend but may occur just as satisfactorily on the straight portions of the curve. The second is that the best point is found to be linked with the grid current bend. When receiving loud signals it was very noticeable that the micro-ammeter in the grid circuit received an impulse with each dot or dash, in the direction which showed a large momentary excess of negative ions flowing to the grid.

[illegible] charge." The explanation is briefly as follows :—The emission from a filament [illegible] saturated. But finally a certain equilibrium density of the negative [illegible] the positive charge on the anode to such an [illegible] field gradient at the surface of the cathode is reduced to zero or nearly so. The negative space charge thus prevent[illegible] of the anode current no matter how much the em[illegible] presence of ionisable gas.

Since the grid is always near zero potential the electric field [illegible] of the drop of potential along the filament produced by the heating current, the field gradient out to the grid becomes increasingly negative toward the positive end of the filament. Assuming the absence of any gas the plate would thus be restrained from attracting [illegible] extend its influence well down between the [illegible]



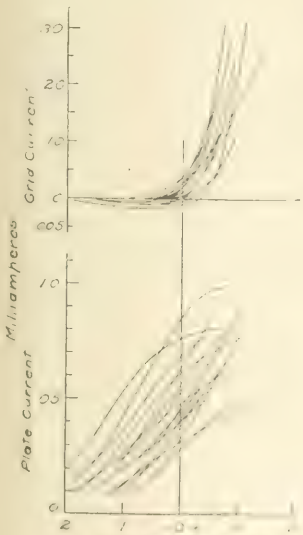


FIG. [illegible] FIG. [illegible] FIG. [illegible]

Knowing that in the [illegible] the detector is working on the straight portion of the plate [illegible] and that, therefore, the [illegible] undergo slight changes of slope, [illegible] he proper position these two [illegible] increase in the other and [illegible]

ACTION OF THE GAS.

[illegible]

[illegible]

Plate Current Curves.—The plate current curve varies, within limits directly with the grid potential because the grid potential (other things remaining constant) determines the electric field inside the grid, and, therefore, the number of electrons which are drawn out between the grid bars to the plate.

Grid Current Curve.—Since the grid is normally negative all along with respect to its adjacent filament, the electric field is opposed to its absorbing electrons and it takes on very few. The positive ions are, on the other hand, attracted to it all along its length, and, as the curves show, it gets the saturation current of them. Changing the grid potential from negative to positive causes part of the grid to begin attracting electrons, and the large supply of them allows it to attract a great many. Thus the grid current curve has a small, nearly constant value below the zero line for negative grid potentials and rises sharply in the neighbourhood of zero potential as the attraction of electrons begins. The location of the bend and the absolute values of the grid current ordinates are determined by the filament current and the plate potential, and also by the shape of the electrodes and by the nature and pressure of the gas. Their influence is exercised through their effect on the body of ions between the electrodes. An equality always exists between the rates of supply and the rates of removal of both kinds of ions, but the equilibrium numbers of the ions present and the actual values of the rates will be dependent on the existing physical conditions as controlled by the factors mentioned. For low plate voltages very few positive ions are formed and the charges collected by the grid and forming the grid current may always consist of a preponderance of electrons. As the plate voltage is raised, more positive ions are formed and contribute to the grid current, while the increased electric field intensity causes the electrons in the neighbourhood of the grid to have a greater tendency to be drawn between the bars out to the plate and a lesser tendency to strike the grid, so that a larger positive potential on the grid is necessary to attract many of them. These two things taken together result in a shift of the grid current curve downward and to the right. Increase in the filament current produces an opposite effect for the reason that it raises the available supply of electrons, thereby increasing the tendency for them to strike the grid. At the same time it somewhat lowers the number of positive ions, because the increased number of electrons which come out from the filament, not being highly heated, low velocity [illegible] inside the grid and near the filament, is a favourable condition for an increased rate of recombination.

The best operating point on the curves is, in every case, just above the bend, as indicated by the experiments. This fact, taken in conjunction with the foregoing discussion, shows that the most sensitive point, the point where the most advantageous bend in the grid current curve occurs, is at the zero current value and where the optimum relation between the flow of the positive and negative ions to the grid is associated with the point where the plate begins to be unable to draw any more electrons from behind the grid, even if considerably more of them are supplied. For higher filament temperatures an excess of electrons is present and although most of them return to the filament still some are forced on the grid even when it is at a negative potential, which means that the bend is [illegible] and also perhaps raised above the zero grid current line. For lower temperatures insufficient electrons are present to supply the demand of the plate, and the electric field near the grid is modified so that the grid cannot easily acquire electrons even when slightly positive. The positive ions form the principal part of the current and the bend occurs less sharply and perhaps below the zero current line. Thus, either above or below the optimum temperature of the filament, conditions are less favourable to sensitiveness, particularly when the blocking condenser is employed. This shows why, in the ordinary use of the audion, the adjustment of the filament current is the final and most delicate one.

The values of plate voltage and filament current necessary for best adjustment are dependent on the nature and pressure of the gas and on the dimensions of the electrodes, since these things affect the amount of ionisation and the shape of the electric field. Decreasing gas pressure in a bulb requires an increasing plate voltage to bring it up to the best condition. This is often noticed in a bulb which is used continuously for some time. The "clean up" of the gas lowers the pressure and the plate voltage must be raised from time to time, until, finally, either the bulb must be discarded or the gas pressure restored by heating up the glass walls. The reason is that the decreased production of positive ions, due to a reduced number of gas molecules, must be compensated by the increase of ionisation and the shift of the grid current curve which can be caused by a higher plate voltage. All of the writer's experiments have been carried on with the residual gas from the ordinary exhausting apparatus, in which case the optimum pressure was 0·005 mm. to 0·010 mm. of mercury. This gas is no doubt made up principally of nitrogen and water vapour with a trace of mercury vapour, oil vapour, &c. Undoubtedly changes in the nature of the gas in a tube would have some effect on the characteristics of the operating curves, since they would be accompanied by changes in the ionising potentials. In a bulb which contains ionisable gas and which is used as a detector considerable changes in the shape and size of the electrodes may be made without appreciable effect on the maximum sensitiveness, because the changes are largely neutralised by the necessary accompanying alterations in the plate voltage and the filament current. This is not true of amplifiers containing very little gas. Variations in the sensitiveness are often observed when a magnetic field is caused to act on the bulb. These variations are due to the effect of the field in shifting the paths of the electrons and thereby modifying the operating curves into more or less advantageous shapes, as the case may be. Bulbs in which the grid and plate but partly enclose the filament are most affected by a magnetic field.

An abnormal condition is encountered when the plate voltage is raised considerably above the ordinary value. A luminous discharge appears in the tube and is seen as a cloud, light blue in colour, between the grid and plate and sometimes extending around the grid toward the negative end of the filament. It is caused by the active and thorough ionisation of the gas by electron bombardment. The appearance of the blue glow is often presaged by a hissing in the telephone receivers similar to the hissing of an ordinary electric arc which is running at too high a current density. In bulbs where the filament is only partly screened by the grid and plate electrodes the glow may, at high voltages, fill the entire tube. With such raising of the plate voltage the characteristic curves of an audion undergo radical changes as shown typically in Fig. 6. The 22·5-volt curves are the normal ones on which good detector action is realised either with or without the blocking condenser. On the 25-volt curves the bulb can be made to work fairly well without the blocking condenser. Between the 25 volt and 33·5 volt curves it is a very poor detector though fair as an amplifier, but above 33·5 volts it is practically useless as either. The successive curves occupy positions farther and farther to the left because the screening action of the grid is reduced by the increasing plate voltage. Not only does the number of positive ions drawn to the grid become larger as the plate voltage goes up, but the shape of the grid current curve, if inverted, shows a peculiar similarity to that of the plate current curve. The two curves are partly interdependent at this stage. An increase in the ionisation modifies conditions around the grid, as has been previously explained, in such a way as to allow a larger plate current, which in turn causes more ionisation and consequently still more plate current, so that the conditions tend toward instability on account of the "progressive ionisation." The increasing effect of this phenomenon can be followed from the place where it is present, but very slightly (25-volt curves) to the place where instability is reached and the changes are critical (37·5 volt curves). Blue glow makes its appearance in the tube at the same voltage at which the current becomes critical. In discussions of the audion it has occasionally been stated that the great sensitiveness of the device is due to this progressive ionisation. The author has found no evidence of such a function in the ordinary range of plate voltages in which successful operation as a detector may be realised. Even good working as an amplifier in the progressive ionisation region is doubtful, for in spite of the great steepness of the plate current curve the grid current curve is also so steep that the power amplification is usually poor.

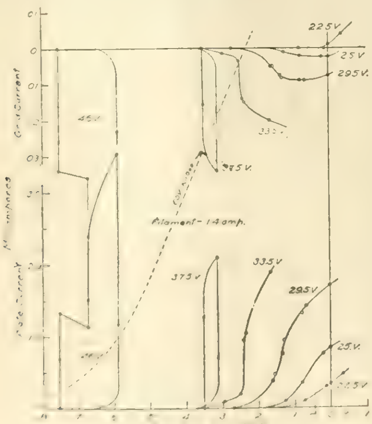


FIG. 6.

A TECHNICAL SPECIFICATION FOR METAL FILAMENT GLOW LAMPS.*

Summary.—This article, by the general secretary of the Association Suisse [illegible] proposed by the Swiss Union of Electricity Works relating to the sale of [illegible] of the specification relating to gas-filled ("half-watt") lamps.

The development in electric glow lamps during recent years has rendered an up-to-date specification for metal filament lamps, similar to that previously imposed for carbon filament lamps, essential. This applies especially to the gas-filled lamps, which have now come regularly on the market, and the manufacture of which has [illegible].

Moreover, difficulties have been experienced in applying to such lamps the photometric methods adopted in the past. For example, the conditions hitherto in vogue entailed measurements of mean horizontal candle-power, the lamp being rotated about a vertical axis during the test. But in recent years lamps have come upon the market which no longer give a fairly uniform distribution of light in a horizontal plane, and the emission in other directions varies so greatly that mean horizontal candle-power no longer gives a correct impression of the total light yielded by the lamps. These difficulties may be removed by the specification of mean spherical candle-power, which can be conveniently measured in the Ulbricht globe. Naturally the new method of expressing candle-power will involve some little adaptation on the part of lamp companies; but the new basis will ultimately be found more satisfactory, as it enables all lamps to be properly compared. It may be mentioned that, for lamps of the ordinary type,† the mean horizontal candle-power is approximately 1·2 times the mean spherical candle-power. A lamp rated at 24 candles on the old system will thus have a candle-power of 20 on the new system of rating.

Another point to be noted is that in the past lamps have been commonly graded in candle-power. At the present time lamps of the most varied specific consumption (watts per candle) are used, and in Switzerland by far the greater proportion of lamps sold are no longer rated in candle-power, but in watts, so that this quantity has an important significance for the consumer. It has, therefore, been decided in the new specification to adopt the more rational grading in watts; but in order to assist the comparison with the previous candle-power rating during the present year, lamps will be sold on the old rating when [illegible] desired. For carbon filament lamps (for which no new [illegible] are proposed) three types of different specific consumption have hitherto been recognised. For metal filament lamps two grades of [illegible] consumption are considered [illegible] type "A" with 800 and type "B" with 1,600 hours' useful life (*i.e.*, a period of 800 and 1,600 hours respectively before the original candle-power is diminished by 20 per cent.). For the gas-filled lamp only one type, with a useful life of 800 hours, is proposed. The relation between [illegible], candle-power, watts, useful life and tolerance are based on an exhaustive series of tests, partly carried out in the laboratory of the Association and partly in other laboratories.

[illegible] Metal Filament Vacuum [illegible]

1. The conditions apply to all [illegible] of not less than 100 [illegible]. They are not applicable to [illegible] of voltages below 100 [illegible] the standard [illegible] of 10, 15, 20, 25, 30, 40 [illegible] lamps with [illegible] or [illegible].

2. Lamps are [illegible] two [illegible] types, of high and low [illegible] useful lives of 800 and 1,600 hours [illegible] A and B.

3. Lamps are to be rated [illegible] watts.

4. Lamps are to be marked on [illegible] with the following information: (1) Mark of the maker; [illegible] (4) indication of type A or B; (5) the mark of the Association "G.E.V." and, at the [illegible] the mean spherical [illegible].

[illegible] must not be [illegible] on the lamp, but the [illegible].

Lamps which do not satisfy or only partially satisfy these requirements will not be submitted to test, and may be [illegible] by the purchaser.

5. Lamps must be without defects as regards [illegible] and [illegible], and must be made of [illegible] without [illegible]. The mounting of the lamp in the socket must be strictly axial, and the attachment of the connection wires to the socket executed solidly and with acid-free solution.

Sockets of [illegible] comply with the [illegible] by the "S.E.V."

6. The testing of lamps for [illegible] candle-power must be done at the supply voltage indicated on lamp.

7. Lamps must comply with the following requirements as regards [illegible]. The [illegible] as determined by test, must not vary above or below the [illegible] by more than 4 per cent. For lamps under 25 watt consumption the variation must not exceed ± 1 watt. The mean spherical candle-power, as determined by test, must not vary by more than 15 per cent. from the data given in the following table:

[illegible]

Consumption, watts.	[illegible] voltage.	[illegible] Type A	Type B
	[illegible]	[illegible]	
10	[illegible]	7·0	—
	[illegible]	[illegible]	
	[illegible]	12·0	
15	[illegible]	[illegible]	—
	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]
20	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]
25	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]
	[illegible]	25·5	[illegible]
30	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]
40	[illegible]	31·0	[illegible]
	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]
50	[illegible]	42·0	[illegible]
	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]
60	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]
80	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]
100	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]

8. By the "useful life" [illegible]

[illegible]

[illegible] power

9. [illegible]

* [illegible]

† [illegible] with straight [illegible] filaments.

10. A consignment of lamps can be returned (*a*) if the useful life of more than 40 per cent. of the lamps tested has not reached 800 hours; (*b*) within 30 days after the delivery of the lamps at the testing laboratory of the S.E.V. if more than 20 per cent. of the lamps tested do not comply with one or more of the prescribed conditions in regard to construction, candle-power or consumption.

If lamps are returned as a result of failure to pass tests of useful life, the cost of such life-tests on selected lamps is to be met by the seller of the lamps. In the event of the purchaser having put into use a portion of the consignment, the above condition shall apply to the remainder of the consignment which has not yet been put into use. Lamps which have been subjected to test may be returned, but those that have been put into use cannot.

11. The place of test prescribed is the Laboratory (Materialprüfanstalt) of the Schweizerischer Elektrotechnischer Verein at Zurich. Lamps for test should be forwarded to this address immediately after the receipt of a consignment by the purchaser.

12. The laboratory of the S.E.V. keeps records of the tests to which appeal may be made in case of dispute, and which are accepted both by the seller and purchaser.

The contesting of consignments rests with the purchaser.

Specification for the Sale of Gas-filled Metal Filament Lamps.

1. These conditions relate to all consignments in which the number of lamps of the same kind is not less than 25. They are not applicable to lamps for pressures below 100 volts, nor to those which deviate from the standard consumptions of 50, 100, 300, 400, 600, 1,000, 2,000, 3,000 and 5,000 watts, nor to lamps with frosted or coloured globes.

2. The lamps shall have a useful life of at least 800 hours.

3. Lamps are to be rated according to their consumption in watts.

4. The following data are to be marked on the socket or bulb of the lamp in clear and legible letters: (1) Mark of manufacturer; (2) pressure; (3) consumption in watts; (4) mark of the Association, "G.E.V."; and, at the desire of the purchaser, also (5) mean spherical candle-power; and (6) mark of the purchaser.

The word "watt" is to be marked on the lamp, but the word "volt" omitted.

Lamps which do not satisfy, or only incompletely satisfy, these requirements will not be subjected to test and may be rejected by the purchaser.

5. Lamps must be without defects as regards construction and material, and must be made of clear glass without blemish and of symmetrical form. The mounting of the lamp in the socket must be strictly axial, and the attachment of the connection wires to the socket executed solidly and with acid-free solution.

Sockets of lamps must comply with the G.E.V. standards.

6. The testing of lamps for consumption and candle-power is to be carried out at the marked voltage.

7. The lamps must comply, as regards consumption and candle-power, with the following standards:

The consumption in watts, as determined by test, should not vary by more than 5 per cent. above or below the value marked on the lamp.

The mean spherical candle-power, as determined by test, shall not vary by more than 15 per cent. above or below the marked value. Further, the specific consumption in watts per candle (Hefner) shall not be higher than the value indicated in the following table:

Consumption, watts.	Maximum specific consumption in watts per candle (Hefner) for pressures of	
	100-125 volts.	[illegible] 250 volts.
50	1·0	
100	0·9	1·0
300	0·8	0·9
400	[illegible]	0·8
600	0·7	0·8
1000	0·6	0·7
2000 and over	0·6	0·65

8. By useful life is understood the period of continuous burning in hours at the stipulated pressure, during which the mean spherical candle-power does not decrease by more than 20 per cent. from its initial value; if the lamp fails before the diminution in light occurs, the period up to the point of breakdown is recorded as the useful life.

The test of useful life is to be carried out at the pressure indicated on the lamp.

For these life tests only lamps which comply with the requirements set forth in (7) are to be employed, and among those the lamps selected whose consumption and candle-power approaches as near as possible to the values marked and specified.

9. The investigation of useful life to be demanded by the purchaser is to be carried out on five lamps of each kind in the consignment. The test of candle-power and consumption is to be applied to 5 per cent., and at least 10 lamps of a kind, from each consignment. Lamps broken in the course of unpacking or testing are to be excluded from the results.

10. A consignment of lamps may be returned (*a*) if more than 40 per cent. of the lamps investigated prove to have a useful life of less than 800 hours; (*b*) within 30 days of the receipt of the consignment at the testing laboratory of the S.E.V., if more than 20 per cent. of the lamps do not comply with the requirements as regards watt consumption, candle-power or one or more of the other stated requirements.

If lamps are returned as a result of failure to pass tests of useful life, the cost of such life-tests on the lamps selected is to be met by the seller of the lamps. In the event of the purchaser having put into use a portion of the consignment, the above condition shall apply to the remainder of the consignment which has not been put into use. Lamps which have been subject to test may be returned, but those which have been put into use cannot.

11. The place of test prescribed is the laboratory of the Schweizserische Elektrotechnischer Verein at Zurich. Lamps for test should be forwarded to this address immediately after the receipt of a consignment by the purchaser.

12. The laboratory of the S.E.V. keeps records of the tests, to which appeal may be made in case of dispute, and which are accepted both by the seller and the purchaser.

The contesting of consignments rests with the purchaser.

Directions for Measuring the Candle-power of Lamps.

Definition of Mean Spherical Candle-power.

1. By mean spherical candle-power is understood the mean of the candle-powers emitted in all directions in space by a glow lamp.

2. The unit of light is the candle, determined by the horizontal candle-power of the Hefner lamp according to the recommendations of the V.d.E. in the year 1911.

Method of Test.

1. The mean spherical candle-power is to be determined by means of the Ulbricht globe, used in conjunction with an illumination photometer. The constant of the globe is ascertained by using a standard calibrated lamp.

2. The Ulbricht globe receives a completely homogeneous white coating on its interior, and is provided with an opening for the insertion of the lamp to be measured, and a second opening, to which is brought the diffusing glass plate of the illumination photometer (Brodhun street photometer, Weber photometer, &c.).

3. In making a test a standard lamp, a calibrated comparison lamp of known candle-power, is first inserted in the globe, and the illumination at the observation window noted with the photometer; this gives the constant of the globe. The lamp to be tested is then substituted for the standard lamp and the value so obtained, multiplied by the constant of the globe, gives the mean spherical candle-power.

Electrolytic Corrosion of Metal in Salt Water.—The "Engineer" remarks that considerable trouble has been experienced at the Panama Canal owing to corrosion of lock gates and machinery due to electrolytic action set up between the iron and steel parts and such adjacent negative metals as copper, bronze and babbit metal. In several cases steel castings and valves have been almost eaten away. To protect the valves from further electrolytic action between the cast steel and the babbit metal the latter has been replaced by greenheart timber. There was also marked corrosion of the tool-steel rollers in the roller trains carrying the lock gates. Some of the rollers, bolts and filler castings have dropped out, due to this injury. In the repairs the bolts were rivetted over to keep them in place. To protect the rollers small pipes were led to the bottom of the roller path, so that crude oil can be discharged. It is expected that this oil will rise and collect upon the rollers, thus insulating them against attacks.

THE SQUIRREL CAGE SPEED INDICATOR.

BY E. B. BROWN, M.SC., A.C.G.I.

Summary. The indicator described depends for its action upon the [illegible] rotating armature in a small generator.

This instrument was developed by the author some years ago in the laboratory of Melbourne University, where several instruments have been running under observation for three years. The results obtained justify the belief that a very simple instrument can be constructed on the same principle accurate enough for commercial purposes, and the accuracy of a precision instrument can be obtained by proper precautions in design.

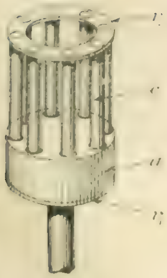


FIG. 1.

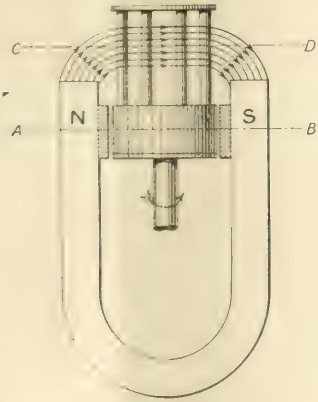


FIG. 2.

The instrument consists of a cylindrical soft iron armature core which can be rotated on its axis between pole pieces attached to a permanent magnet. This armature is provided with slots or tunnels carrying a number of insulated conductors short-circuited by rings at both ends of the armature in a manner similar to the well-known squirrel cage winding used in induction motors. At one end of the armature the squirrel cage projects considerably beyond the armature core as shown in Fig. 1, in which a is the armature core, which may or may not be laminated; c are the conductors which may be any number from three upwards; and r_1 and r_2 are the short-circuiting rings.

The conductors c are insulated at the slots from the core but the ring r_1 need not be insulated and may be sweated or screwed on to the core.

When the armature is rotated, as in Fig. 2, between the pole pieces of a permanent magnet NS, E.M.F.s are set up in the conductors. If the armature is rotated round the axis [illegible] in the direction of the arrow the E.M.F.s will be upwards on the left hand side of the armature, and downwards on the right hand side. There will consequently be a field of currents flowing up one side of the armature and down the other, as shown in Fig. 3, which is a section of Fig. 2 in a horizontal plane through AB. The direction of the currents in the conductors is indicated in Fig. 3, and also the forward displacement of the line of zero current, which results from the self-induction of the armature winding.

As is well known, the currents flowing in the conductors of the projecting squirrel cage winding produce a cross magnetic field in the space within it, represented by OD in Fig. 4, which represents a section across the projecting part of the squirrel cage winding at CD in Fig. 2 by a horizontal plane. In this plane there is already a magnetic field due to leakage from the magnet poles which is called "the initial field" and represented by OF in Fig. 4. The field OD due to rotation of the armature is called "the deflecting field," and combines with OF, "the initial field," to produce OR, the resultant field.

The direction of OR, "the resultant field," depends on the speed of rotation of the armature, and it is only [illegible] to add a small pivoted vane of soft iron attached [illegible] and some form of damping mechanism, to [illegible] a practical speed indicator. Fig. 5 is a diag[illegible] of a complete instrument, in which the soft iron vane i is enclosed in a fixed tube to prevent the action of air currents and is attached to a vertical pivoted axis which also [illegible] an air damping vane d and a pointer p moving over a gra[illegible] scale s.

As is usual in instruments of this type, the moving element is balanced about its axis by balance weights (not shown in Fig. 5), so that the instrument can be used in an inclined position.

It may be remarked that no control spring is necessary, because the plate of soft iron takes up the direction of the resultant field, and also that moderate variations in the [illegible] of the magnet will not affect the indications of the instrument, because they affect both initial and deflecting fields in the same ratio, so that the direction of the resultant is unchanged.

The calibration curve of one of the instruments used in Melbourne University is given in Fig. 6, whi[illegible] form of scale obtained. This particular instrument [illegible] close to dynamos and motors and is provided with a ca[illegible] case to diminish stray field errors. The upper ring [illegible] is made of an alloy with a low temperature [illegible] of electrical resistance, in order to diminish errors due to change of rotor resistance with temperature.

Under the conditions in which it is used the instrument gives readings which may be relied on within [illegible] ½ per cent.,

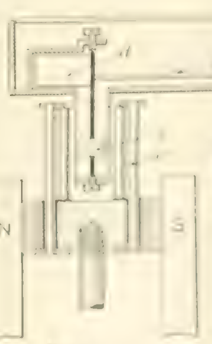
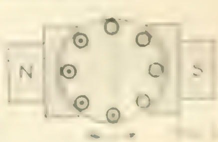


FIG. 5.



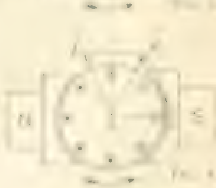


FIG. 4.

[illegible]

[illegible]

A[illegible] following [illegible]

[illegible]

The following symbols are used :—

R=Resistance of armature winding.
L=Inductance of armature winding.
$p=2\pi n$, where n is the armature speed in revs. per sec.
E=Armature E.M.F. induced by rotation in the field at a speed n.
$E=\lambda p$, where λ is a constant.
I=Armature current.
φ=The angle of lag of current behind E.M.F. in the armature.

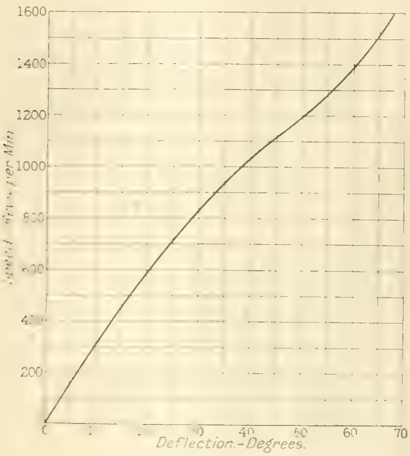


FIG. 6.

Between these quantities the following relations hold :—

$$I=\frac{E}{\sqrt{R^2+L^2p^2}}=\frac{\lambda}{L}\sin\varphi,$$

$$\sin\varphi=\frac{Lp}{\sqrt{R^2+L^2p^2}},$$

$$\cos\varphi=\frac{R}{\sqrt{R^2+L^2p^2}}.$$

Referring to Fig. [illegible], the deflecting field OE is at right angles to the [illegible] current and therefore makes an angle φ with the [illegible] and OE is proportional to I, so that $OE=kI$ where k is a constant.

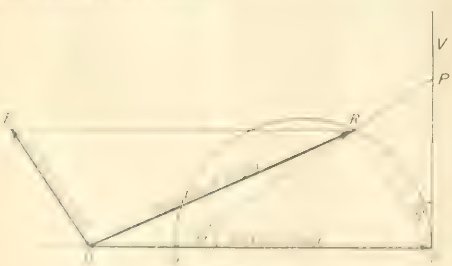


FIG. [illegible]

At the speed represented by OP [illegible] [illegible] [illegible] [illegible] [illegible] OF represents the initial field and OE the [illegible] field, and OF [illegible] ER [illegible] the [illegible] field.

Through F a line GRP is drawn perpendicular to FR cutting [illegible] and [illegible] I in G and P respectively.

Then $PFR=PGF=\varphi$,

$$GF=\frac{kI}{\sin\varphi}=\frac{k\lambda}{L}, \text{ a fixed length,}$$

$$FP=\frac{kI}{\cos\varphi}=\frac{k\lambda p}{R} \text{ is proportional to the speed.}$$

A semi-circle is described on the fixed base GF and passes through R.

The following construction will now be self evident :—In order to get the direction and magnitude of the resultant field for any speed, cut off to the proper scale a length FP proportional to the speed and join GP, cutting the semi-circle in R; then OR represents the resultant field.

With the conditions shown in Fig. 7 the maximum deflection would be attained for a speed at which OR is a tangent to the circle, and at higher speeds a lower deflection would result.

A large maximum deflection is possible if the initial field OF is lessened, or what is better, if the deflecting field is relatively stronger. Such a condition is shown in Fig. 8, in which the point O lies within the circle, and a series of positions OR_1, OR_2, &c., are shown for the resultant field corresponding to speeds FP_1, FP_2, &c. The increments of speed are chosen equal, *i.e.*, $FP_1=P_1P_2=P_2P_3$, &c., so that the figure shows the increments of deflection for equal increments of speed.

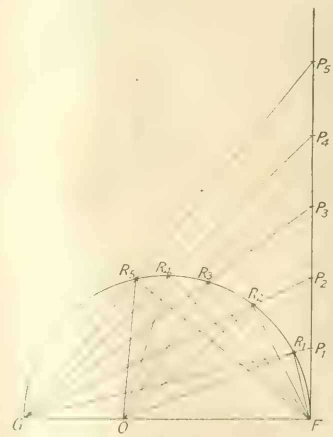


FIG. 8.

An interesting case occurs when O coincides with the centre of the circle. The tangent of half the angle of deflection is then proportional to the speed.

The initial field can be varied in strength by sliding the magnet up or down on the pole-pieces, which provides a convenient means of adjusting the sensibility, and also enables experiments to be tried on the effect of varying the initial field. A set of calibration curves may thus be obtained from one instrument, which agree closely with the curves deduced from theory up to about 50° deflection, but for higher speeds a larger deflection is obtained than that predicted from the theory.

The theory given may not be complete, but it is useful in designing the instrument because it shows the effect of varying the relative [illegible] of the different quantities concerned.

BOOKS RECEIVED.

[Copies of the [illegible] can be had from THE ELECTRICIAN Offices, on receipt of published price [illegible].]

"Design and Construction of Industrial Buildings." By MORITZ KAHN. (London: Technical Journals, Ltd.) Pp. xii + 63. 62 plates. 7s. 6d. net.

"Year Book of the Swedish Chamber of Commerce for the United Kingdom, 1916." (London: Swedish Chamber of Commerce.)

"The Housing Question as Affected by Recent Legislation." (London: [illegible]) [illegible] net.

MODERN PHYSICS.*

BY R. A. MILLIKAN.

If you have any respect for my subject or any respect for me, you will not expect me to outline in the space of one brief hour the work of modern physics. It is utterly impossible to do, and I can say that without affecting an inordinate egotism. The spirit of modern science is something relatively new in the world's history, and I want, as an introduction to the main address, to give an analysis of what it is. It has three elements. The first is a philosophy, the second is a method, and the third is a faith. Look first at the philosophy. I say that is new for the reason that all primitive peoples, and many that are not primitive, have held a philosophy that is both animastic and fatalistic. Every phenomenon which is at all unusual or for any reason not immediately intelligible used to be attributed to the direct action of some invisible personal being. Now, the philosophy of physics, a philosophy which was held at first timidly, always tentatively, always as a mere working hypothesis, but yet held with ever increasing conviction from the time of Galileo, when the experimental method may be said to have had its beginnings, clear up to the present time, is the exact antithesis of the above. Stated in its most sweeping form it holds that the universe is ultimately rationally intelligible, no matter how far from a complete comprehension of it we may now be or indeed may ever come to be. It believes in the absolute uniformity of Nature.

Second, as to the method of science, it is a method practically unknown to the ancient world; for that world was essentially subjective in all its thinking and built up its views of things largely by introspection. The scientific method, on the other hand, is a method which is completely objective. It is the method of the working hypothesis which is ready for the discard the very minute it fails to work. It is the method which believes in a minute, careful, wholly dispassionate analysis of a situation; and any physicist or engineer who allows the least trace of prejudice or preconception to enter into his study of a given problem violates the most sacred duty of his profession.

At the end of the nineteenth century there were many of us physicists and engineers who thought that all the great discoveries had been made. It was a common statement that this was so. I heard it publicly made in 1894, and yet within a year of that time I happened to be present in Berlin at the meeting of the Physical Society at which Roentgen showed his first photographs, and since that time we have had a [illegible] world, the very existence of which we undreamed of before, opened up to our astonished eyes.

But we must not focus our attention too intently upon the utility of a discovery. If you ask me what are the utilities of the particular category of discoveries which I am going to run over here very rapidly, I may be able to tell you of a [illegible] of them, but I shall not try to catalogue them all, because that is not where our immediate interest lies; it is "where there is no vision [illegible] the people perish."

[illegible]

of the molecules become electrically charged and begin to jump, some of them [illegible] plate, [illegible] instrument. [illegible] call an atom has electrical charges as its const[illegible] history of the last 20 years in physics has [illegible] determining what are the properties of th[illegible]

The third is the discovery of radio-activity, [illegible] a little after the discovery of X-rays. And [illegible] matter doing things we had never dreamed it w[illegible] ing off from itself both negatively and positive[illegible] the negatives with a speed which may approach[illegible] of light, 186,000 miles per second, and posit[illegible] one-tenth of that, or 18,000 miles. The fact th[illegible] be imparted to projectiles of any kind was undr[illegible]

The fourth [illegible] atomicity of electricity, the proof that [illegible] exactly alike, and that what we call an electr[illegible] simply in the journey along the conductor of th[illegible] which we may call with perfect justice definite [illegible]

The fifth great discovery of modern ph[illegible] of evidence for the electrical origin of m[illegible] matter is electrical in origin? The last is not [illegible] electrical charge possesses inertia or mas[illegible] there is no inertia in matter which is [illegible] Now we have a certain amount of evid[illegible] have good reason for assuming that the [illegible] but a disembodied electrical charge, a[illegible] of electrical origin. With resp[illegible] haven't that evidence as yet, bu[illegible] simplicity to assume one kind of [illegible] good reason to think, at any rat[illegible] electron in the hydrogen atom, [illegible] positive is almost the mass of th[illegible] never find it any less. Further [illegible] atom consists of a body with [illegible] rays of radium.

This brings me to the sixt[illegible] *of the nucleus atom.* Then [illegible] which did not merely tell [illegible] there are in the nucleus but it [illegible] in the field [illegible] made by R[illegible] ether pulse[illegible]

[illegible]

* [illegible]

and all the interests of the eternally infamous men who made this war are not to be compared in value to the world with a hair of Moseley's head. Yet he had to be sacrificed to save a threatened civilisation. A double honour to Moseley.

His discovery was this: He was analysing the characteristic X-rays which are given off when any kind of a substance is bombarded with cathode rays. The experiment was in my judgment as brilliantly conceived, as carefully and skillfully carried out, and as illuminating in its results, as any which has been done in the last 50 years. What he found was this, that the atoms of all the different substances emit radiations or groups of radiations which are extraordinarily similar, but that these radiations differ as we go from substance to substance in their wave lengths. The whole discovery can be stated in this fashion: If you take the highest frequency emitted by a given atom, and if you lay down on a table a length which is equal to the square root of this frequency, and if on top of that you lay down the square root of the frequency of the atom which has the next lower frequency, and so if you continue to lay down, with one group of ends together, the measured square root frequencies of all the elements that you can study, then what have you got? You find that you have a flight of stairs, with perfectly definite equal treads; that is, the frequencies change by definite steps as you go from element to element. And there are only four vacant treads between the lightest element which Moseley could study, namely, aluminium, and the heaviest one, namely, lead, thus indicating that there are only four elements in this range which we have not already found.

My last of the great discoveries of modern physics is one that I will just touch upon. It is the discovery of quantum relations in photo-electricity, in X-rays, and in optical spectra; but here I am coming to a field which we do not know very much about, which we do not yet understand.

I feel just as sure as Shakespeare did that "there are still more things in heaven and earth than are dreamed of in our philosophy," and if we stop, it will be because we have forgotten the lesson which Galileo first tried to teach, and which we have been learning in the last 100 years, and that is the lesson of research. It is the lesson, the philosophy, the method and the faith of modern physics. That is our hope, and if we keep that, if we don't call in our scouts because the rewards are larger in the applications, then I haven't any doubt that our civilisation will go on; and if we do call in our scouts here in this country, then our civilisation will give place to that of some other country which does not do so, but which learns the value for the human race of the spirit of modern scientific research.

DISTURBANCE OF TELEGRAPHIC COMMUNICATION IN THE RHONE VALLEY THROUGH THE OPERATION OF THE LÖTSCHBERG ELECTRIC RAILWAY.*

BY M. DUMERMUTH.

Since the opening of the electrically-operated Lötschberg Railway all the telegraph wires of the Swiss railways running into Brig were so strongly affected that communication was at times quite impossible. The telegraph wires run along the railways, and are all single with earth return. An unsuccessful attempt to eliminate these disturbances was made by removing the earthing point of the telegraph wires from Brig to [illegible]. It was still impossible to telegraph [illegible] any train was running between the stations of Brig and [illegible] along the Rhone Valley.

[illegible] were then undertaken to determine the nature and cause of the disturbances and to devise means for their removal. A number of oscillograms were taken of the currents flowing in the telegraph wires, typical curves being shown in Fig. 2, in which the currents are compared in a railway telegraph wire between Sion and Brig, and in a postal telegraph wire between Brig and [illegible]. The current [illegible] was [illegible], which corresponds to 12·6 volts, calculated from the known resistance of the circuit. It will be noted that there is considerable phase displacement between the currents. The frequency of the currents was measured by superposing on oscillograms of the disturbance currents [illegible], with the result that it was found that the disturbance currents had a frequency of 15 cycles a second, which is the frequency of the Brig-Lötschberg Railway supply.

As the centre of the disturbance was probably near Visp, a further study was made of the currents in the separate sections Sion–Visp and Visp–Brig. The measurements in the former section were obtained by disconnecting the earth at Brig, and connecting the Sion–Brig line through the measuring instruments to a local wire running from Brig to Visp, and earthing it at Visp, thus forming a practically non-inductive loop between Brig and Visp. The induced voltage was about the same magnitude and of the same frequency, as shown in Fig. 2, when a train was running from Brig to Hothen. The curve of Fig. 3 was obtained on the section Visp–Brig when no train was running, and shows the electrostatic disturbance arising from the charging of the trolley wire at 15,000 volts. The fundamental wave of frequency 15 cycles a second shows a marked superposed harmonic of a frequency of about 600 cycles a second.

A new series of tests were now made between Brig and Blitzingen, using a postal telegraph wire between these stations. It could be assumed that, as Blitzingen is about 25 km. from Brig, the earth at Blitzingen was outside the region of the disturbances arising from the Brig–Lötschberg Railway. Fig. 4 shows a typical oscillogram, the induced voltages on the two sections under comparison being about 39 volts on the wire between Sion and Brig and 6 volts between

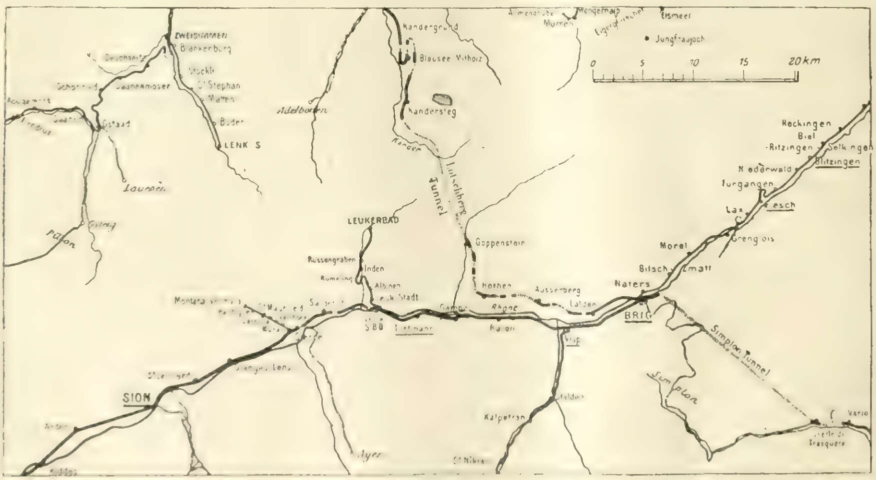


Fig. 1.—Map of the Lötschberg Railway.

* Abstract of an article in the "Elektrotechnische Zeitschrift," No. 1, [illegible]

Brig and Blitzingen. The oscillograms in this series of tests also show a considerable phase displacement between the currents in the two sections, which points to the conclusion that stray or earth-currents cannot be the sole cause of the disturbances, but that they must originate to a great extent from electromagnetic induction. Both Sion and Blitzingen lie outside the area of disturbance, and so their earth plates may be assumed to have the same potential.

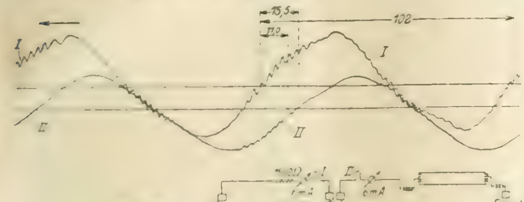


FIG. 2

If, therefore, the disturbances on the Brig–Sion and the Brig–Blitzingen lines were due to earth-currents, the voltages in the two sections would be equal, as the earth at Brig is common to both. Now the oscillograms show that the voltage on the Sion–Brig line w[illegible] as on the Brig–Blitzingen line. From this fact, and the phase displacement of the currents, it therefore

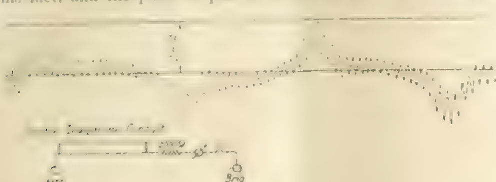


FIG. 3.

follows that the inductive [illegible] far greater than the disturbance caused by earth-currents, and that the disturbance on the Brig–Blitzingen line is to an appreciable extent due to earth-currents, while the disturbance on the Brig–Sion line is principally to be ascribed to induction. This is corroborated by the oscillogram (Fig. 4), showing the current in a line between Sion and Blitzingen

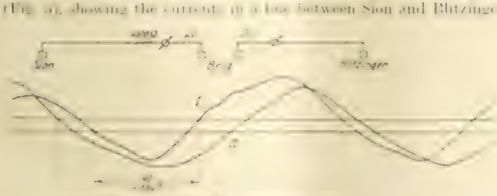


FIG. 4.

[illegible] with the current in a line between Sion and Brig. [illegible] earth-currents in the [illegible] as the two ends are at the same earth potential. [illegible] effects must have been [illegible] to the [illegible] used from the [illegible] of the railway. The oscillograms show that there is a slight difference between the two [illegible] to the earth-currents that

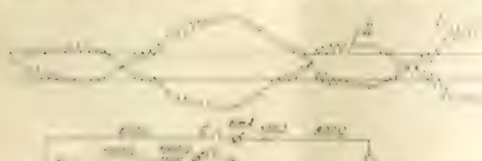


FIG. 5.

[illegible]

[illegible] it follows that the [illegible] is mainly due to induction. [illegible]

FIG. 6 is [illegible]
between [illegible] in different sections of the [illegible]
The [illegible]
Sion–Brig [illegible]
Blitzingen [illegible]

As a practical result of the experiments the earthing point of the telegraph lines was transferred from Brig to Visp, and, although the disturbances were not quite eliminated thereby, communication became fairly good except at times when there was exceptionally heavy traffic on the railway. It is intended to lay a new earthing wire to Turtmann, 23 km. from Brig, and it is expected from preliminary experiments that the disturbances will be practically removed.

It appears therefore that in order to eliminate inductive effects it is necessary to remove the earthing point of the telegraph wires from Brig in the direction of Sion—*i.e.*, *into* the area of origin of the disturbance, so that the inductive effect are able to be compensated in the insulated earthing wire. A removal of the earthing point *out of* the [illegible] avail. The transfer of the earthing point from Brig to Visp [illegible] line by 50 per cent. [illegible] 85 per cent. The [illegible] them altogether.

FIG. 6.

METER ACCURACY ON ARC FURNACE LOADS.

In [illegible]
[illegible] an induction meter on this service was [illegible] meters were installed [illegible]

[illegible]

The Electrician.

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THE PLACE OF THE PHYSICIST IN ENGINEERING.

No alliance is more essential to progress than that of the man of action with the man of thought. That anyone will dispute this is unlikely, for it is one of the principles of modern civilisation. We feel, nevertheless, that the principle is one which needs emphasising, since on our faith in it depends our future position among the nations of the world. Time was when the man of thought made thought his aim. The man and his thoughts lived behind blind walls; they lived, died and were forgotten together. It is therefore hardly to be wondered at that thought came to be looked at askance.

A remnant of this attitude is seen in the names given to those schools whose special function is to teach the alliance of thought with action. Instead of schools of science they are called schools of *applied* science; instead of schools of chemistry or of optics they are schools of *technical* chemistry or *technical* optics. In these schools it has become an unwritten law that science shall never be taught merely for science's sake, and that a teacher shall never fail to answer in terms of £ s. d. the question, "What is the use of it?" We are of opinion that the worship of "practical application" is in danger of being carried too far. Among the remarkable shortcomings of the modern student on leaving his technical school are slovenliness and carelessness of detail in experimental work. His highest aim is "commercial accuracy." This, we believe, results directly and unavoidably from aiming at the deplorably low ideal of "commercial utility."

The history of engineering during the past 150 years shows greater advance than was made in all the preceding ages, and this advance has resulted directly from careful thought based upon careful experiment. The essential knowledge upon which engineering advance has been based was won by men who, fortunately, were far too keenly engrossed in the search after knowledge for its own sake to worry about its immediate application.

And certainly during the past twenty years the evidence has been manifest that progress in engineering has depended above all upon the men who have sought knowledge not with any thought of its immediate application, but rather because of the faith they have had in its intrinsic power for good. Such men have become known as pure physicists. It is time their importance to engineering was more widely understood.

The [illegible] recognition by engineers and manufacturers of the importance of the physicist [illegible] of the [illegible] which men have the habit of [illegible] to all sorts of [illegible] of which they were unable to [illegible] the real meaning [illegible] at the present time.

In the accompanying [illegible] Paper on "Modern Physics" read by Prof. Millikan before the American Institute of Electrical Engineers is of great interest. Prof. Millikan [illegible] what he considers to have been the ten discoveries [illegible] "the ten most important advances of the last twenty years." "If you ask me," says he, "what are the [illegible] of ten particular epochs of discovery, I may be able to tell you of a good many of them, but I shall not try to catalogue them all, because that is not where our immediate interest lies; it is 'where there is no *vision*' that 'the people perish.'"

A striking paragraph is that in which the lecturer refers to Moseley—the young English physicist whose loss the nation will never be able to make up. "This discovery [that of important new relations between the elements] was made by a young Englishman only 26 years old, Moseley, who has already, unfortunately, fallen a victim to this juggernaut which is at the present time crushing out the finest scientific brains in the world. Moseley was killed at the age of 27, a year after he made his epoch-making discovery, and all the lives and all the interests of the eternally infamous men who made this war are not to be compared in value to the world with a hair of Moseley's head. Yet he had to be sacrificed to save a threatened civilisation. A double honour to Moseley."

All engineering depends for its success upon a knowledge of the properties of materials. Many of these properties are isolated facts, of which, before their discovery, we had hardly dreamed. Because of this, much of engineering advance has been by slow groping in the dark. The man who can throw a little light upon the question of the ultimate constitution of matter brings nearer the day when it will be possible not only to predict the properties of a given combination of elements but also to predict the combination of elements which shall have desired properties. Moseley's discoveries represent one of the most remarkable advances that ever have been made towards a complete explanation of the relation between the chemical elements, and seems to bring us within reach of the secret of their transmutation.

Nevertheless, we doubt whether so many as one in twenty of the engineers in this country have even so much as heard of Moseley.

"It is 'where there is no vision' that 'the people perish.'"

Where was the "vision" of those who allowed Moseley to be sacrificed?

We feel, indeed, that lack of vision has proved, especially of recent years, a weakness that has cost this country very dear.

The ten discoveries enumerated by Prof. Millikan bear, all of them, upon the question of the atomicity of matter, and of electricity—the substance of which matter seems to be built. In mentioning a few of the more important developments in engineering which, already, have grown out of these discoveries, Prof. Millikan is careful to emphasise the foolishness of judging of the value of physical research in terms of the commercial worth of its immediate application. "The utilities might come, they always do come, but they generally crop out as by-products, and the man who has got his mind fixed merely on utilities is simply the man who kills the hen to get the golden egg. I have just as much respect for utilities as you or anybody has. I believe that nothing is worth except as it contributes in the end to human progress, but the difficulty is you cannot tell, nor can I or anybody else tell what is going to contribute to human progress."

The fetish of immediate utility has already greatly retarded engineering progress in this country, and there never has been a moment that has called us so imperatively to give up this fetish as the present. The engineer who applies scientific knowledge in the construction of great works serves his country measurably well; the physicist who adds a new fact to scientific knowledge serves his country immeasurably well. The physicist is the pioneer upon whose work every advance in engineering depends.

THE QUESTION OF NITROGEN FIXATION IN THE U S.A. FOR PURPOSES OF WAR.*

The following report to the Ordnance Department (U.S.A.) by Mr. C. L. Parsons (Chief Chemist, Bureau of Mines), dated January 27, 1917, was written after a trip to Italy, France, England, Norway and Sweden, visiting many plants producing nitric acid :—

The conclusions are based on the maximum requirements for munitions purposes of the United States Government of :—

In time of peace	20,000 tons of nitric acid.
In time of war	180,000 tons of nitric acid.

The increase in the output of ammonia from by-product coal since 1915, if oxidised to nitric acid, is alone more than sufficient to meet this requirement. The oxidation of ammonia, including that produced from the destructive distillation of coal, presents no serious difficulties, and the necessary plants using the emergency procedure adopted in Germany could, in case of need, be quickly installed to meet the Government requirements.

In my opinion the following methods include the only ones which need to be considered in the final choice of the procedure to be employed by the Government in providing [illegible] nitrate supply :—

1. Nitric acid may be obtained directly from the air, with no raw material except that contained therein by directly burning the nitrogen and oxygen of the atmosphere by means of the electric arc.

2. Nitric acid may be obtained from the oxidation of ammonia.

The processes to be considered are :

(*a*) Arc process, in which nitrogen and oxygen are directly burned to nitric oxide under the influence of the electric arc.

(*b*) Haber process, in which nitrogen and hydrogen are directly combined to form ammonia.

(*c*) Cyanamide process, in which carbon and lime are first heated in an electric furnace to form calcium carbide. The carbide is then treated with pure nitrogen to form cyanamide, and, in turn, the cyanamide is hydrolised by steam in special autoclaves to produce ammonia.

(*d*) By-product ammonia, obtained as a by-product in so-called by-product coke ovens by the destructive distillation of bituminous coal.

(*e*) Cyanide process, not yet commercially developed, but carrying great promise of cheap combined nitrogen. This process embraces the direct combination of nitrogen, carbon and sodium to form sodium cyanide by heating together an intimate mixture of carbon, soda ash and nitrogen in the presence of finely divided iron.

All the processes producing ammonia involve the further oxidation of that ammonia to nitric acid. The ammonia may be oxidised by means of heated electrically or otherwise [illegible] by presenting as large a surface as possible of glowing platinum to the proper mixture of ammonia and air, under which conditions the nitrogen in the ammonia burns to nitric oxide. The methods to be [illegible] for the oxidation of ammonia are :

(*a*) Ostwald Barton method [illegible] in France and England, and probably also in Germany.

(*b*) Frank Caro method, now [illegible] 100,000 tons of concentrated nitric acid in Germany, [illegible] experimentally installed with modifications in two small plants in [illegible]

(*c*) The oxidation in solution of [illegible] or dicyanamide to ammonium nitrate, as yet carried out only in an experimental installation in Sweden, and being installed in [illegible] now in process of erection, one near Gothenburg, Sweden, and the [illegible] and larger plant near Berlin, Germany.

THE A[illegible]

[illegible] was the first [illegible] process to be developed for the fixation of nitrogen. It is [illegible] in Southern Norway, [illegible]

[illegible]

Incidental to the production of [illegible]

[illegible] methods for its application [illegible]

[illegible]

In spite [illegible] general opinion of the European engineers with whom I came in contact that even with the cheap horse-power enjoyed by the Norwegian plants, they might have had to discontinue their operations except for the stimulus given by the present European war. Even as it is, the Norsk Hydro Company, operating the arc plants at Notodden and Rjukan, has been obliged to install large ammonia-producing plants in order that they might convert their nitric acid to ammonium nitrate, and thus render it transportable to markets where it was needed.

The cost of power used for the production of nitric acid in Norway is less than \$5 per horse-power-year. The best estimates indicate that with power at \$10 per horse-power-year the cost of finished strong nitric acid at the plant would be as cheap as by any other process now in operation. However, "the low cost of producing nitric acid by the arc process is outweighed by so many disadvantages that in my opinion, the process is entirely inapplicable to the uses of the United States Government. The cost of installing the arc process is high, and it involves the use of an amount of horse-power that seemingly is not available on the American Continent within reach of the points where the nitric acid would have to be used. Nitric acid is not economically transportable. As strong nitric acid it can be transported only if tank cars made of aluminium can be obtained, and aluminium is a metal that for this purpose has many disadvantages besides cost. The nitric acid might be transported mixed with sulphuric acid in iron tank cars, but this involves the erection of large sulphuric acid factories near to the nitric acid plant and a large addition in freight rates.

Nitric acid does not readily lend itself to the production of fertiliser material, although it may be neutralised with lime to form calcium nitrate or with ammonia to form ammonium nitrate.

The great difficulty that has faced the Norwegian plants from the beginning—namely, a market for their products—would in peace times be a serious obstacle to the operation of a large arc plant in the United States. An arc plant at its best involves the use of 2·33 H.P.-year per ton of weak nitric acid. This means that a water-power development of at least 50,000 H.P. would be necessary for the peace requirements of the Government, and a development of 440,000 H.P. would be required for war purposes. [illegible] relatively high efficiency reached in Norway. No installation should be considered by the Government of less than 75,000 H.P. for peace requirements or 550,000 H.P. for war requirements. If the arc process is to be used it would also be advisabe to arrange for the production of explosives it the point where the arc plant was situated. This would, of course, involve the transportation of all other raw materials needed to the plant and the transportation of the finished explosives therefrom to the place of consumption.

An arc plant [illegible] ment in time of war [illegible] during times of peace, owing to the difficulty of disposing of the nitric acid that the plant would produce if in operation. On account of the large amount of horse-power required and the consequent extent of the necessary plant and tower absorption capacity, the cost of installing an arc plant [illegible] several times the total appropriation made for the purpose by Congress.

1. [illegible] efficiently utilised in a large plant run continuously to capacity.
2. [illegible]
3. [illegible]
4. [illegible]
5. Small amount of labour involved.

[illegible]

munitions.

[illegible]

* Abstract of report [illegible] Industrial and Engineering Chemistry, U.S.A.

compete, when the war is over, with all other processes for the fixation of nitrogen and also with Chile saltpetre in the fertiliser markets.

By the Haber process, nitrogen from the air and hydrogen obtained from water are directly combined to form ammonia under the influence of finely divided iron. The production and purification of hydrogen made either by the reducing action of coal or iron upon steam involves one of the chief items of cost in the Haber process. The fact that the combination of nitrogen and hydrogen takes place at temperatures above 500°C., and at pressures of 125 to 150 atmospheres involves some danger and many other technical difficulties, which have, however, seemingly been overcome in Germany.

Trustworthy information regarding the costs of production of ammonia by the Haber process indicates that pure anhydrous ammonia can be produced in liquid condition for a cost slightly less than 4 cents per pound. It is the cheapest process for the production of synthetic ammonia. It is independent of cheap power—the power being a small fraction of its cost. If desirable, it could be readily installed in moderate-sized units in connection with ammonia oxidising plants at any munitions plant.

Advantages.—1. Cheap ammonia.

2. Ammonia in water-free liquid condition ready for immediate oxidation without purification.

3. Availability of raw material (air, water, and coal).

4. Possibility of erecting comparatively small plants wherever needed.

5. Easy availability of product for transportation and for fertiliser.

Disadvantages.—1. Inability to procure technical details, use of method, and trained technical force without the assistance of the Badische Company, except as the result of many months and probably years of experimentation.

2. High repair and renewal costs.

3. Undoubtedly high royalty that would be demanded if the Government were to install and operate this process itself.

4. Patents and processes controlled in America by one corporation.

CYANAMIDE PROCESS.

The cyanamide process has been developed in many parts of Europe, but in the Western Hemisphere only at Niagara Falls, Ontario, Canada. It requires cheap power for its successful operation, and has obtained its greatest development owing to the fact that it requires only about one-fifth the horse-power per ton of fixed nitrogen per year that is required by the arc process. In other words, from a definite horse-power installation the cyanamide process produces about five times the amount of combined nitrogen that is produced by means of the arc process.

The raw materials required are coal for lime burning, anthracite coal or coke for the production of calcium carbide, limestone essentially free from magnesia, fluorspar, and nitrogen obtained from liquid air.

The cost of ammonia from cyanamide, with power at $8 per horse-power-year in a plant to be constructed by the Government would be 1 to 2 cents per pound more than by the Haber process. On the other hand, royalties for using the cyanamide process would undoubtedly be less. The technical problems involved are understood by many engineers both in this country and abroad, the manufacture of calcium carbide and cyanamide being established in many plants, and the basic patents having only some four years more to run. Peculiarly favourable conditions exist for its installation in certain sections of the South. If a hydro-electric plant is to be installed by the United States Government, and the [illegible] power so developed must be used for the fixation of nitrogen, the cyanamide process has advantages over all other processes now developed, and should be adopted as the best means of utilising [illegible] for the fixation of nitrogen.

In Germany in 191[illegible] there were produced 30,000 tons of cyanamide. [illegible] as in the case of the Haber process. [illegible] by the German Government to [illegible]. However, the 1917 German production will [illegible]. The cyanamide interests in Germany [illegible] German Government to establish a [illegible] the continuation of the cyanamide [illegible] the Haber process and ammonia [illegible] after the war. The German nitrate [illegible] by the [illegible] chiefly owing to [illegible] Haber patents.

[illegible] product, and in order [illegible] with oil or [illegible] special [illegible] the material to be more [illegible]. Cyanamide [illegible] and probably is, [illegible] to the soil. It has not, however, [illegible] fertiliser manufacturers, and is not well [illegible] fertiliser demanded by American [illegible] cheaper [illegible], at the end of the war, one [illegible] requirements of 20,000 [illegible] cyanamide, [illegible] 11,000 [illegible] and 19,000 [illegible] respectively.

[illegible] the most popular form of fertiliser [illegible] it would cost approximately [illegible] cents per pound [illegible] present into the form of ammonium [illegible] sulphate. It is the necessity [illegible] of the cyanamide [illegible] and that makes up a considerable portion of the difference in cost between cyanamide ammonia and Haber ammonia.

Advantages.—1. Most available method if hydro-electric power is to be used.

2. Moderate horse-power requirements.

3. Ready transportability.

4. Product saleable in time of peace for fertiliser.

Disadvantages.—1. Number of operations and plant installations required to produce nitric acid—viz., carbide, cyanamide, ammonia from cyanamide, ammonia oxidation, and nitric acid concentration.

2. Patents and processes controlled in America by one corporation.

3. Process an extremely dusty and disagreeable one, involving unpleasant conditions, if not hardships, on the labour.

4. Large labour factor involved.

5. Comparatively high cost.

(*To be concluded.*)

CORRESPONDENCE.

ROUGH-AND-READY COSTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In considering the many advantages that would result to the brass trade (and even to many other trades) through some scheme of co-operation, one can imagine the good effects it would have throughout the manufacturing world if it did nothing more than teach many manufacturers the correct way to cost their goods.

It is simply appalling to learn of the methods that some firms use to cost their products. One manufacturer I know takes the total piece work price of the labour required to produce a given article, adds the cost of material, and then doubles it, the resulting figure giving him his selling price. The "doubling it" is supposed to cover all his process work, which is executed at day-work rates, such as cleaning, dipping, barrelling, annealing, polishing, lacquering, his warehouse handling, his distribution expenses—in fact, all his overhead charges and profit—and because at the end of the year he finds his business undertakings have acquired for him a profit, he considers himself a capable and successful business man.

He has no *certain* knowledge that any particular article is showing him either a profit or a loss, but he is content to "carry on," probably selling a third of his products at an actual loss, as long as he makes up the deficiency with the other lines.

As business is being carried on by so many people who know nothing of the scientific side of costing, the above example is quite common, and it is unfortunate, as these manufacturers quite unknowingly spoil the trade for themselves and all concerned. Quite a lot of what is termed "cutting" or selling at "rotten prices" is due, not to any desire to cut prices, but to ignorance of the correct methods of costing, and, unfortunately, accountants are few and far between who can give really useful help in this direction, for many of their methods are even to-day very rough and ready, and display a lamentable want of knowledge on this most vital subject. Manufacturers themselves should make a careful study of the science of costing, and many should cast on one side all their preconceived notions of this most important subject, and study the question afresh.—We are, &c.,

Birmingham, Oct. 16. SMITH & DAVIS (LTD.)
HOWARD F. SMITH, Director.

FAILURE OF FUSE CLIP HOLDERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With regard to the letter of Mr. Murdoch's in your present issue, I think the trouble is very general.

I have not had a great deal of experience with A.C. work with this type of fuse holder, but my experience with D.C. makes me think that constant alterations in the current is in some way responsible. I have noticed that breakages are far more numerous in circuits that are frequently broken than in circuits which are generally left undisturbed, either "on" or "off."

Another point is a wax-like deposit of verdigris which is frequently found with clips of this type. I have never found any explanation for it, and can only come to the conclusion it is the result of what may perhaps be termed electrolysis. It is certainly more noticeable in circuits that are more heavily loaded.

I think Mr. Murdoch has hit on a subject that will most likely pay for investigation, as there seems to be no very definite ideas of *why* the trouble he mentions is so frequent.

In any case the pattern is most unsatisfactory, and offers a large field for improvement.—I am, &c.,

London, Oct. 20. H. W. STOWERS.

A NEW QUALIFICATION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Knowing the interest you and your readers take in educational matters, I venture to write you concerning another terror which has been added to the lot of applicants for teaching posts in our technical institutes.

The Borough Polytechnic Institute have inserted in their form of application for a lecturer in their engineering dept. a new particular to be inserted—namely, the *height* of the candidate! It is difficult to imagine why this information should be required. Might not a great deal of trouble to applicants be saved if a minimum height was stated as a *necessary qualification* for the advertised post ?—I am, &c.,

London, Oct. 17. A. T. T. I.

EFFECT OF THE WAR ON MUNICIPAL ENGINEERING.

In association with the Chadwick Departments of Municipal Engineering and Hygiene, an introductory lecture was given at University College, London, by Mr. H. Percy Boulnois, M.Inst.C.E., on "The Effect of the War on Municipal Engineering and Public Health." Sir Maurice Fitzmaurice, C.M.G., presided.

Mr. Boulnois said it was doubtful whether the general public fully appreciated the important bearing which municipal engineering had upon their daily life and health. The modern tendency for people to aggregate into large and often overcrowded centres had made them more and more dependent upon the local municipal authority, and thus the individual had lost some of the personal responsibility which he formerly possessed, and relied more and more upon official protection. The neighbourhood in many cases was dependent upon the municipal engineer for supplies of gas and electricity, and tramcars in which he could ride at very small expense. The war had perforce stopped a number of municipal works which were in process of construction, but all the obligations arising out of the war had been in nearly all cases satisfactorily settled without recourse to the law courts. That was entirely due to the good feeling which existed between the contractor and the local authority owing to the crisis into which the country had been plunged. He had had to deal with two or three very complicated cases of this description which were amicably settled after a great deal of trouble, and he wished to express his appreciation of the sympathetic attitude of the Local Government Board, who of course had to be consulted with regard to all these affected schemes. With regard to any detrimental effect upon public health, he did not think, so far as he could ascertain, that up to the present time there had been any such effect due to compulsory closing down of these works. There was another point where the effect of the war was seriously felt, in connection with works which had to be completed or partially completed on the ground of public health. Some works, of course, were in such a condition that they would not be closed down, and had to be completed. It was impossible for the contractor or the municipal engineer to obtain either materials or labour to do the work within the estimated or tendered cost or within anything like the time specified. Here again good feeling had prevailed, and the give-and-take principle had to be applied, with satisfactory results. He doubted if the general public realised the amount of quiet and unostentatious work that had been carried out for their benefit owing to the [illegible] changes produced by the war. Nor must it be forgotten that this work had been carried out with greatly depleted staffs. A large number of municipal engineers and their qualified assistants had either joined the forces or taken up national service in one form or another; at least [illegible] members of the Institution of Municipal and County Engineers had done so. In regard to street lighting, the lecturer said there was now more light thrown on the surface of the streets, and less showing more light upwards, by means of more scientific construction of the lantern, and by reducing the candle-power of the lanterns. He thought the darkening of our streets would lead to a much more scientific arrangement with regard to street lighting. Street lighting was, as a rule, unscientifically considered. What was wanted was a diffused light, and that was what was now given.

Sir Maurice Fitzmaurice, in proposing a vote of thanks to Mr. Boulnois, said although everyone was very willing to do anything they could in these times, he could not help feeling glad that his work as a municipal engineer had been in happier times. Of course, nearly everything had been allowed to slide except matters connected with the war during the last three years, but although that was the case—we found it every day—he thought there were very few of us who truly realised what the great extent and cost of reconstruction were going to be after the war. Consider the reconstruction which would be necessary in the railways in this country, the Overseas Dominions and all foreign countries, the roads, water supply, drainage, housing, new works for electric current, lighting and power, development of our agriculture and of all our natural resources—all these things were going to cost money, but there was a great deal more than that—we had also to go into the question of making use of all the Government factories and other Government buildings which had been erected during the war, in settling the best way to deal with them and to get some value out of them. Particularly in municipal matters it would be very important that we should make up for lost time. We had got to bring matters up to the state they would have been in if there had been no war. London, perhaps, was better off than most municipalities in that way, but to mention only one glaring thing—in London their supply of electricity, split up among a large number of stations, was, in his view, a perfect scandal to the country. That, of course, was due to the original Electric Lighting Orders being carried out when they did not know very much about this kind of work, and to the fact that the Government had not tackled questions of the kind.

AN ELECTRIC LORRY AT BRISBANE.

The City Electric Light Co. (Ltd.), Brisbane, Australia, recently put into service a 5-ton electric self-tipping lorry for the purpose of carting coal from the Roma-street railway coal chutes to their power station in William-street, a distance of about 1¼ miles. The lorry, which weighs approximately 10 tons when loaded, is propelled by an electric motor, operated from a 44-cell Chloride Co.'s Iron Exide storage battery. Its range, when loaded, is 45 miles on one charge, with a speed of 7 miles per hour. The body of the lorry can be elevated to an angle of [illegible] deg., [illegible], whilst it is filled by gravity at the coal chutes. The elevating of

the body itself is done by [illegible] Vehicle Co., [illegible] lorry [illegible] the large [illegible]

LEGAL INTELLIGENCE.

British Magneto Manufacture.

In the Patents Court last week the British Lighting & Ignition Co. asked for licence to use 24 Bosch and other German-owned magneto patents.

Mr. J. Hunter Gray said the applicant company was formed in May last to acquire the plant, machinery and factory of the Bosch Magneto Co. (Ltd.), which was practically entirely owned by German capital. The Bosch Magneto Co. had 120 patents or applications, and, of course, it was known the Bosch magneto practically held the field in this country before the war. The purchasers were Messrs. Vickers (Ltd.), who formed the present applicant company to work the various machinery, plant and factories which were bought from the Controller. They paid a large sum of money. He did not think the magnetos before the war were even assembled here. They came over actually completed and assembled, and all the firm did here was to effect repairs to damaged Bosch magnetos. So there was no industry in this country at all. He did not want the licence to be made out for the term of the war only, seeing the great amount of money that must be spent to get the industry into this country. Applicant company had a capital of £200,000; very substantial sums had been spent by it since the purchase was made. Those magnetos were now being made in large numbers, and the applicant company, with a capital such as it had and the plant which was being installed would be able to supply the demand for magnetos in this country. A licence had already been given to the Chesham Supply Co. to manufacture and that the sum which was fixed as payable by way of royalty was arranged at 5s. per magneto. That, he thought under the circumstances, was very generous. The royalty might very well be smaller when one considered the enormous sums of money being spent by the applicants, and no doubt by the Chesham Co. if they were going to manufacture in any quantity at all. He was told that the biggest output, which occurred about the year before the war, was 100,000, for the United Kingdom and the Colonies, excepting Canada.

The Controller: That gives £25,000 a year royalty—a very large sum.

Mr. Gray: Before the war practically the total output of magnetos in this country was by Bosch. The time and pains spent in getting the big output by the Germans made it possible for them to prevent almost anybody else selling. Other applications to the Court were not so important, as getting the entire industry of a manufacture like that in this country. When one considered the great expense to be incurred, he thought they would see there a reason why a small royalty should be given. Counsel said the superiority of the Bosch magneto was due to good work and good design. He could pass up, as a note, to the Court the number the applicant company was turning out now per week for war work; it was a very large number. They hope to go on increasing that number during the war and after, but they would not be able to do it unless they got a big market. They could only get that and beat the German if they had those highly developed works and equipment which would enable them to compete with Germany after the war. The Chesham Supply Co. applied only for nine patents and only two of those were common to theirs and the present list. The whole of the 24 for which he asked, with the exception perhaps of three or four, were embodied in the magneto actually made. Four patents referred to the oil parts. As to the interrupters, the patents were alternative and for another part, also the patents were alternative. Certain patents dealt with an oil pump. The Bosch Co., in addition to selling magnetos, sold oil pumps, and as the applicants had taken over the plant which related [illegible] to make those as well. They would be [illegible] per pump. The pumps sold separately and the [illegible] £20. He hoped that after the war the Board of Trade would ensure that nothing should happen to prejudice the position of the [illegible] industry.

[illegible] W[illegible] pointed out that in all the licences there was provision for reconsideration after the war.

Mr. Gray: But here you are dealing with a whole industry. The problem is on a large scale and unique.

Mr. A. [illegible], patent agent, said he represented the patentee on the [illegible]. He had written to his correspondent in Berlin and offered [illegible] in the hands of some other patent [illegible]. The only answer he got was a wire back: "No protest."

Mr. [illegible], general manager of the British Lighting & Ignition Co., said he was [illegible] of the Bosch Magneto Co. from 1907 until it was [illegible] and that the Colonial business [illegible] 50 per cent. of the output was from this [illegible]. The price before the war would range from £6 to [illegible] but for motor cars [illegible] from [illegible] to £12. He calculated that [illegible] of the country. [illegible]. The plant would have to be [illegible] the quantity [illegible] concentrating [illegible] great number of types of [illegible].

The Controller: [illegible] the success of the Bosch [illegible]?

[illegible] W[illegible]: [illegible] of the works. Mr. Bosch's [illegible] were situated in a part of Germany which was very far away from the natural sources of [illegible] in that part by doing [illegible] the Bosch magneto was due to admirable workmanship, and the company could secure good workmanship here. They were making magnetos for most of the aircraft at the present time. They could turn out a machine equal to the Bosch, as far as the material available permitted it. They could produce all the metal parts: it was only a matter of experience to get the material up to the excellence that the Germans attained. The Bosch Co. only made machines in London for the purpose of competition where it was laid down that the whole engine had to be of British manufacture. He would like the royalty to be as small as possible because he was responsible.

Commander Bristow, from the Admiralty, gave evidence, and said he agreed with what Mr. Gray said. He saw no reason why the manufacturer in this country should not have a licence and he agreed that the sum of 5s. for royalty was excessive. The Government had been in consultation with patent experts and their view was that upon the validity of those patents they could put up a very decent fight. They would challenge the validity of all those patents, except perhaps two, one dealing with the central terminals and the lagging pin, and the other a patent on the hole in the contact-breaker cam, which was fitted with a wick which took the oil in the surface of the cam. The number of magnetos imported to this country before the war of all sorts from America, Germany and oddments, amounted to 280,000 a year. So that if the trade was struggling under a royalty of 5s. a magneto it would be paying to Bosch in Germany £70,000 per annum. A licence goes in for several years, so that a very big amount at that rate would be paid to the German for a number of patents of which it was said that they were not valid. The following companies are also manufacturing:—The British Thomson-Houston Co., The British Westinghouse Co., Siemens, Ericsson, Peel-Conner, Thomson, Bennett, the M.-L. Magneto Syndicate, the Watford Speedometer Co., the Fellowes Magneto and others. The total capital of those companies must run into millions of pounds. For the first five alone the capital was very considerable. All those proposed to continue after the war. All these firms are members of the British Magneto Manufacturers Association, and they unanimously agreed that they would fight the Bosch Co. if necessary. He believed they had established some sinking fund or reserve to enable them to engage in litigation with the Bosch Co. if the Bosch Co. wanted it. The upshot of all their consultations had been that whatever others might do, they had definitely made up their minds that they would not apply for a licence. And they were anxious that nothing should be done by anybody else to prejudice the position which they had taken up with regard to the validity of the patents. Although the Government saw no objection to Messrs. Vickers having a licence the Government would not regard it with equanimity if any clause were inserted in the licence which made them appear to be sole licensees.

The Controller: The licence would only be between the applicants and the Board of Trade, and no licence for war use could ever be taken to be a general guarantee of the validity of the patent rights.

Commander Bristow: Say, for instance, that the British-Thomson Houston Co. were using a certain patent, we should not like it to be possible for the Bosch Co. to say "It does not matter what you think about its validity. A licence has already been granted in respect of it, and the Patents Court has recognised it."

The Controller: What will be the demand for the output of magnetos after the war?

Commander Bristow: With 280,000 a year required before the war it is highly probable that that number will be greatly exceeded after the war. There was a great movement for reforming the motor trade and by standardisation to place this country in a much better position to fight the importation of these foreign cars.

Mr. Temple Franks announced that the licence would be granted, and added: "It may be that now we shall reconsider the whole question of royalty and recommend the Board of Trade that all people who come for licence, possibly including the Chesham Co., should have the royalty based on the new considerations we have heard."

VOLUNTEER NOTICES.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Oxford-street, W. 1.

Orders for the Week.

Lieut.-Colonel C. B. Clay, V.D., Commanding.

Officer for the week.—Lieut. W. J. A. Watkins.

Next for Duty.—Sec. Lieut. P. Bowden.

Drills: Week ending Sunday, Nov. 4, 1917.

Monday.—No. 3 Company, Left Half. Recruits. Signalling, 6.30.

Tuesday.—Physical Drill and Bayonet Exercise, 7.30.

Wednesday.—No. 1 Company, 6.30.

Thursday.—No. 2 Company, 6. Signalling. Ambulance, 6.30.

Friday.—No. 3 Company, Right Half. Recruits, 6.30.

Sunday.—Commandant's Parade: Parade Waterloo Station opposite No. 10 Platform, 8.[illegible] a.m., for work at Esher. Uniform. Mid-day rations to be carried. Compulsory for "A" and "B" men.

Musketry.—[illegible] road, Tuesday, Wednesday and Thursday, 5.30 to [illegible]

Note.—The Medical Officer will attend for Examination of Recruits, &c., on Thursday, at 6.

All enamelled cap badges must be returned to the Quartermaster-Sergeant without delay.

The Regimental Tailor will attend on Tuesday, Oct. 30, at Headquarters at 6.30, to measure for uniforms.

Unless otherwise indicated all drills will take place at Headquarters.

COMMERCIAL & INDUSTRIAL SECTION.

Submarine Telegraphy in War Time.

From the report of the proceedings at the annual meetings of the Eastern and Eastern Extension Telegraph Companies, which appears [illegible] columns, it will be seen that both companies have had a large expansion of business. The gross receipts show remarkable increases and the higher rates of dividend, which were declared last year, have been maintained, while the reserve and depreciation funds have been greatly strengthened. It is a pleasure to be able to point [illegible] the electrical industry in which British enterprise is supreme, but it is mainly due to those gentlemen who are responsible for the policy of the Eastern and its associated companies that [illegible] position. Owing to the war the meetings have been held six months later than usual, but this delay did not interfere with the distribution of the dividends. Though the chairman could [illegible] details of the services rendered by the companies to the Empire and our Allies in the ar, yet it must be manifest that the rapid and reliable means of communication which they provide between the Mother Country and her various possessions overseas is invaluable in the present strenuous times. With the return of peace no doubt we shall learn more ab out the value of the very imp rtant [illegible] and by those responsible for [illegible]

* * * *

Dick, Kerr & Co.'s Report.

The accounts of this leading firm of contractors and electrical manufacturers for the past year show an increase in the profits as compared with the previous year. The net profit for the year to June 30, 1917, [illegible] and the amount brought forward [illegible] £115,862, out of which it is proposed to pay a 10 per cent. dividend on the ordinary shares of the company, to place [illegible] reserve and to carry forward [illegible]

[illegible]

* * * *

Federation of British Industries.

[illegible] at the annual meeting of the Federation of British Industries [illegible] the retiring president [illegible]

[illegible] in many instances [illegible]

[illegible]

Government Control of Trade.

A public meeting [illegible] held yesterday [illegible] of Government [illegible] following [illegible] Merchants' Committee cf the London Chamber of Commerce were passed :—

(a) That [illegible] between [illegible] the services of the business community.

(b) That to this end merchants shquld be encouraged to continue to carry on [illegible]

(c) That [illegible] the [illegible] allocation of quantities amongst merchants dealing in particular articles, after consultation with representative trade organisations. Permits should [illegible] merchants and importers to the trade involved.

(d) That the various control departments should be co-ordinated so far as [illegible] present delays [illegible]

(e) That [illegible] representative business men nominated by their respective [illegible]

(f) That [illegible] of Parliament [illegible] of this committee.

* * * *

Chambers of Commerce and Reconstruction.

Trade and industrial reconstruction is being considered by chambers of commerce in a serious manner. Already the matter has been discussed by some of the provincial chambers, and at the last meeting of the Council of the London Chamber the question of [illegible]

[illegible]

* * * *

Work of British Chambers of Commerce Abroad.

In the [illegible] have not in general [illegible]

[illegible]

* * * *

[illegible]

ELECTRICITY SUPPLY.

EXTENSIONS.

Greenock.—Last week the Corporation considered a report on the capital required by the electricity department.

It was stated that £6,000 was required to complete old contracts, £13,000 for additional mains and services in Greenock, £8,000 in Port Glasgow, £10,000 for land and property extensions at Dellingburn power station and £16,000 for transforming plant and switchgear, a total of £53,000 for immediate requirements. In the near future further expenditure will be necessary. A local firm contemplates large extensions which will create a great demand for electricity, and in addition to making mains and sub-stat on extensions for this consumer it will be necessary also to add to the generating plant at the station. Extensions are also in progress in many of the other large consumers' premises, so that it would be advisable when making the application for borrowing powers to intimate that further borrowings would be necessary at an early date.

On the motion of the Provost, seconded by Mr. M'Callum, convener of the Electricity Committee, it was agreed to ask the Secretary for Scotland for power to borrow £53,000.

Southend.—An inquiry was held last week on behalf of the Local Government Board into the application of the Corporation for sanction to borrow £45,520 for additional generating plant for the electricity works and £4,150 for the purchase of electric vehicles for the collection of house refuse.

Swansea.—Owing to the increasing demand for electric current for power the electric Lighting and Tramways Committee proposes to put in a new turbo-alternator of 3,000 kw. or 5,000 kw. capacity.

Willesden.—The Urban Council has applied for sanction to borrow £3,350 for a new h.t. cable.

GENERAL.

Belfast.—The Tramways and Electricity Committee has refused to accede to the application of the National Amalgamated Union of Labour on behalf of their members employed in the electricity department for a minimum wage of 50s. for all adults now getting less than 40s. per week, and an increase of 10s. per week for all now getting 40s. per week and over.

Bradford.—The Electricity Committee recently re-affirmed its proposals that power consumers with maximum demands under 5 kw. and power consumers on the restricted hour rate shall pay an additional rate in accordance with the price of coal (equal to an increase of about 20 per cent. with coal at its present price), that other consumers' rates shall be increased 10 per cent., and that heating and cooking consumers be supplied at [illegible]d. per unit, plus 10 per cent. to consumers already taking supplies for other purposes.

The subject was discussed at the meeting of the Corporation last week but the report was referred back.

On Tuesday, however, the Electricity Committee decided once more to re-affirm their recommendations.

Coal Clause in Electric Power Contracts.—The Stalybridge, Hyde, Mossley and Dukinfield Joint Tramways and Electricity Board has decided to increase the figure in the coal clause in contracts for power supply from [illegible] to [illegible].

Greasborough.—The Council have decided to proceed with their application for a provisional order, but further consideration of the matter has been adjourned to give Rotherham Corporation an opportunity to submit terms for the supply of current.

Hampstead (London).—The Lighting Committee recommend an expenditure of £200 upon [illegible] illuminated signs indicating "Take Cover" and "All Clear" at many important points in the borough. The signs are to be operated by the police.

Leeds.—The equipment of the new automatic telephone exchange is making steady progress, and it is expected that it will be opened early next year.

Liverpool.—Some particulars of the progress of the electric supply department were given by the chairman of the Tramways and Electric Power Committee (Ald. Taylor) at last week's meeting of the Committee.

[illegible]

economies and advantages of electric driving were receiving greater recognition, as was shown by several large important manufacturing firms adopting that method. The work of the department had been carried out under great difficulties owing to the depletion of the staff and workmen through the calls of the military authorities. In addition, the resources of the staff of the department had been very much strained, as a considerable amount of time had been expended in laying out, advising and superintending the large installations which had recently been connected.

The lighting of the city was carried out at present by means of 5,770 lamps, made up as follows, viz.: Incandescent gas 4,918, flat flame 408 and electric 444. That represented approximtaely one quarter of the total number of lamps fixed. Although the number of lamps lighted was practically the same as last winter, there was a decided increase of lighting.

Llandudno.—The report by Mr. W. H. Patchell, consulting engineer, on the Council's electricity undertaking, has been received, and will be considered by the Electricity Committee at an early meeting.

St. Pancras (London).—The salary of Mr. T. W. Merry, superintendent at King's-road electricity station, has been increased to £250 per annum.

Taunton.—Some anomalies in the method of charging for electric current were considered by the Council last week.

The Electricity Committee reported that they had received complaints from consumers in cases where the charge for electricity consumed had been higher than would have been the case if a larger quantity of units had been consumed at a lower rate per unit. The committee were of opinion that that anomaly in the scale of charges should be abolished, and had therefore decided, subject to the approval of the Council, that in any case where a consumer of current would be chargeable, under the existing scale of charges a greater sum than would have been the case had the consumption been sufficient to bring such consumer under a lower rate of charge, the consumer should be called upon to pay only the minimum amount which he would be called upon to pay under the lower rate of charge.

Councillor MOLE, in proposing the adoption of the report, pointed out that under the sliding scale of charges, if a consumer used less than 26 units per quarter he was charged 6d. per unit, from 25 to 500 units 4½d., and from 500 to 1,000 units 4d. Thus, it was possible for a person to use 550 units at a less cost than if he used 500 units. In the same way if a person used 25 units he would be charged at the 6d. rate, but if he let his meter run to 27 units he would only be charged at 4½d. It was, therefore suggested that when the accounts were sent out they should be calculated on whichever basis was lowest for the consumer, and if the consumer used 24 units he should have the right to pay for 26 units at 4½d. per unit.

The report and recommendation were approved.

ELECTRIC TRACTION.

Blackpool.—The Tramways Committee has decided to apply to the Board of Trade for permission to run cars in tandem, the front car drawing the second as a trailer. The reason of the application is depletion of staff owing to the war.

The tramways manager (Mr. Chas. Furness) is making preparations to increase the number of tramcars as soonas the present restrictions are removed. He proposes to obtain 16 additional cars, which will bring the total up to 100, and to improve and enlarge the rolling stock as soon as circumstances and the Minister of Munitions permit.

Lancashire Tramways Award.—The arbitrator in the recent arbitration between the employees and owners of tramways in the Lancashire district has now decided that the working week consists of six days or shifts, and that if an employee works seven days he is entitled to an extra amount.

Most of the tramway employees work seven shifts a week, and will receive an award of [illegible] a week in most cases, and in some instances 15s. a week as the result of the decision.

Liverpool.—At the final meeting of the Tramways, Electric Power and Lighting Committee for the present municipal year, Ald. E. Russell Taylor gave particulars of the progress of the tramways undertaking of the Corporation.

Ald. Taylor said the first nine months of the year had proved a record over all previous corresponding periods. The receipts were £603,317, an increase of [illegible] over the previous year. The passengers carried numbered 127,119,191, an increase of 9,868,437; the car mileage run was 9,414,628, a decrease of 90,303; and the earnings per car mile were 1s. 3.13d., an increase of [illegible]. The work of the department had been carried out under very strenuous conditions. The difficulty of obtaining supplies of material to maintain the rolling stock and overhead equipment in an efficient state of repair, together with the difficulty of finding substitutes for the large number of employees who had joined H.M. Forces (about 2,200) to repair and operate the cars, had been a constant source of anxiety. Notwithstanding these difficulties, however, the rolling stock and overhead equipment had been maintained in a perfectly safe and serviceable state of repair, and a sufficient staff had been obtained to

provide an efficient service of cars on all routes. That had been rendered possible by employing 1,500 females, and a number of men unfit for military service. Despite those efforts, however, a considerable amount of congestion took place on certain routes during crush hours. The congestion was not so much brought about by a depletion of the service as by the enormous increase in the number of passengers compared with pre-war times. While the increase in passengers for the first nine months of the year, compared with 1916, was nearly ten millions, as compared with the corresponding period in pre-war times it was an increase of 28 millions, which showed a total annual increase over pre-war times of about 36 millions.

In [illegible] last the committee approved a report of the general manager recommending a series of [illegible] circular routes, making the Old Haymarket the general town terminus. The object of those routes was to obviate congestion generally, but particularly in the central area of the city, and also to reduce the car miles run at the fag end of the journey. Three of the routes had already been put into operation, and had proved eminently successful, both as regarded the financial result and the obviation of congestion. The amount of war bonus paid to [illegible] wages or salary up to £400 a year was approximately £41,000 per annum, while the amount payable by the tramways department [illegible] the difference in wages between Army allowance and standard rate of pay to employees who had been mobilised for H.M. services was approximately £30,000 per annum. Up to the present [illegible] to the number of 2,950,803, equal to [illegible], and free [illegible] to the number of 165,550, equal to [illegible].

Metropolitan Association of Electric Tramways Managers.—A meeting of the members of this Association was held at the Municipal [illegible] Club, Whitehall Court, Whitehall, S.W., on the 19th [illegible] were present:

Messrs. Ullmann (East Ham), Harvey (Ilford), Hammond (Met. Electric), Williams (Erith), Stokes (Bexley), Mason (South Met.), Mac. [illegible]. Messrs. Ullmann, Hammond [illegible] chairman, vice-chairman and [illegible] to be left over for [illegible] meeting.

Southend.—[illegible] certificate for the [illegible] & Jefferies, of four electric [illegible].

Weymouth.—The [illegible] Committee has reported that [illegible] had been severely hampered [illegible] and growing cost of hired [illegible] task of purchasing horses [illegible]

[illegible]

MISCELLANEOUS.

Aircraft Production.—[illegible]

[illegible]

Alleged Theft of Lamp Bulbs.—At Guildhall (London) Police Court on Saturday, Simon Deitch, electrical engineer, was charged with being concerned with others in breaking into the warehouse of the De Battery Co., Ltd., Aldersgate-street, and stealing [illegible] Bulbs value £1,800. When arrested, Deitch stated that he bought the lamps from a traveller of a firm in Milton-street. 5,300 bulbs were found in a box under prisoner's bed.

Prisoner was remanded and admitted to bail [illegible].

Electrical Workers' Wages.—The Committee on Production have awarded to the members of the National [illegible] Engineman, Firemen, Mechanics, Motormen and [illegible] Workers who received the advance of 12s. per week in June last a further advance of 3s. per week [illegible] Aug. 1, 1917.

The amounts now awarded are to be regarded as war advances, and are to be recognised as due to and dependent on the existence of the abnormal conditions now prevailing in consequence of the war.

The award applies to sub-station engineers, enginemen, firemen and trimmers, &c.

Employers and Recruiting.—[illegible] labour to make a return [illegible] and on a form D.R. 17 [illegible] officer of the district in which the men work.

A duplicate form should be kept by the employer on the premises, and both should be [illegible] that failure to comply with this regulation entails heavy penalties under Defence of Realm Regulations 41a.

Engineering and Shipbuilding Trades' Federation.—The Executive Council of the Amalgamated Society of Engineers [illegible] take a ballot on the question [illegible] It is considered that the present [illegible] action, and is not sufficiently representative.

Liability for Air Raid Injuries.—In the Bow County Court on Tuesday Judge Graham, K.C., [illegible] which raised the point whether [illegible] air raid whilst at work was entitled to [illegible] Compensation Act.

The Judge held that it was for the respondent to pro[illegible] was running nothing more than a common risk, and th[illegible] had failed to do [illegible] they happened to be in particular places by their emplo[illegible] not because they happened [illegible] the same risks at all times and in all places and whether employed or not, as in the case of a man struck by lightning. He made an award in favour of applicant, but granted leave to appeal.

Postponed Bonus.—[illegible] hart.

[illegible] the employers was most irregular. The [illegible] was whether a certain bonus for certain [illegible] production. On Aug. 27 the arbitrator decided that the bonus should [illegible]

Prohibited and Restricted Exports.—[illegible] exports:

[illegible]

Storage of Coal.—[illegible] inferior quality has to be [illegible]

EDUCATIONAL.

South Western University[illegible]

University College[illegible] construction [illegible]

University of Bristol.—Mr. Henry H. Wills has presented to this University buildings and ground to the extent of nine acres for future extensions.

University College of South Wales and Monmouthshire.—At the [illegible] a vote of thanks was [illegible] Sir W. [illegible] Bart., for his munificent gift [illegible] to be called the Tatem Chemical [illegible]

[illegible] Sir Wm. Tatem's generosity [illegible] that would compare [illegible] British university [illegible] 1,000 guineas [illegible]

Technical Education.—At the meeting of the Birmingabm Rotary [illegible] Brockington, Director of Education for Leicestershire, in the course of a discussion on the Education Bill, said we wanted technical schools absolutely and intimately in touch with the particular industry or branches of industry associated [illegible]

[illegible] during the war? Their machinery must be not behind; it ought to be a little in front of local machinery. He believed that the present bill provided the means, but it was for the manufacturers and the trade [illegible] specific training [illegible] one in which the resources of science should be brought to bear upon [illegible] The [illegible] must view with apprehension the extension of the powers of a State department. The cumulative effect of certain clauses of the bill was to increase largely the duties of the Board of Education to concentrate administrative power, to centralise administrative control, to impair the powers of local education authorities—and thus, it might be feared, [illegible] government in this country.

TENDERS INVITED AND ACCEPTED.

House Service and Fuse Boxes and Fittings.

[illegible] tenders for the supply of house service boxes and fittings and house fuse boxes and fittings. Forms of tender and specification from the deputy electrical engineer, [illegible] tenders to the Town Clerk, Municipal buildings, Victoria-street, Grimsby, by first post, Oct. 29.

Electrical Fittings.

[illegible] require tenders by [illegible] for 12 months' supply of Electric Fittings, Lamps, &c. Cable and Wire, Carbons, &c. Forms of tender from the Secretary, Amiens-street, Dublin.

Railway Signalling Apparatus.

[illegible] Railway Commissioners require tenders by [illegible] for power signalling (contract 30,989). Specifications from the Commissioners' [illegible]

Wiring and Fitting.

[illegible] for the electric lighting of the Central Tubercoulosis Institute, Durham-street, Belfast. Specification [illegible]

London County Council.—The following tenders have been [illegible]

[illegible]

motor converter for £1,000.

[illegible]

Glasgow.—The Tramways Committee has placed an order with the British Insulated & Helsby Cables (Ltd.) for trolley wire.

Bradford.—The Corporation have accepted the tender of the British Hele-Shaw Patent Clutch Co. for 162 steel pinions at £212.

Transformer Contracts.—Messrs. Ferranti, Ltd., Hollinwood, Lancs., and Kingsway, London, W.C., have received an order from the Yorkshire Electric Power Co., for one 150 k.v.a. and one 200 k.v.a. three-phase transformers; and from the British Cellulose & Chemical Mfg. Co. for three 10,000 k.v.a. three-phase transformers for furnace work (secondary current 50,000 amperes).

Feed Water Regulator Contracts.—Messrs. Scholey & Co. (Ltd.) 56, Victoria-street, S.W. 1, inform us that they have received a large number of orders for Cope's patent feed water regulators, including Sheffield [illegible] (repeat order), Manchester and Birmingham electricity departments, the Yorkshire Electric Power Co. (repeat orders), Messrs. Babcock & Wilcox, and many industrial firms. Test and other reports fully demonstrate the [illegible] which result from [illegible] feed water control.

APPOINTMENTS VACANT AND FILLED.

A junior shift engineer or improver is required for a large power station in the north. *See advertisement.*

A [illegible] is required for tramways substations. Duty average 50 hours per week. Wages 50s., rising to 60s. a week, with 2s. 6d. a week war bonus. Applications to the General Manager L.C.C. Tramways, 62, Finsbury-pavement, London, E.C. 2. *See advertisement.*

A teacher of physics is required at Merchant Venturers' Technical College, Bristol. Salary £200 per annum if a man, or £170 if a woman (with less work). Particulars from the Registrar.

A lecture assistant is required in the chemical department of the Battersea Polytechnic, London, S.W. 11. Applications to the Secretary.

An assistant electrical engineer is required for the Government Railway Department, Gold Coast. Salary, £300, rising to £350. Applications to Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's-gate, London, S.W. 1.

Preston Corporation are recommended to appoint Mr. Henry Clayton as assistant engineer and manager of their tramway undertaking.

Blackpool Electricity Committee have made the following appointments:—

Mr. Geo. Yates, [illegible] fittings superintendent, at £200 per annum, rising by annual increments of £25 to £250; Mr. Herbert Makin becomes [illegible] clerk, at £180, rising by £10 to £200; Mr. Walter Unsworth, invoice and ledger clerk, at £150, rising to £160. 10s. at the end of 12 months; and Mr. T. W. Leatherbarrow, stores clerk in the electricity department, at £135, rising to £150.

BUSINESS ITEMS.

Plant for Sale.—Mr. T. Griffith, Gwydyr Ucha, Llanrwst, advertises for sale some electric lighting plant.

Patent Development.—The proprietor of British Patent No. 9,046 of 1914, desires to sell same or to licence British manufacturers. Particulars from Messrs. Boult, Wade & Tennant, patent agents, 111 and 112, Hatton-garden, London, E.C. 1.

Alien Enemy Patents.—Messrs. J. S. Highfield, A. A. Campbell [illegible] and P. D. Tuckett have applied for licences for using three patents of the [illegible] Elektrizitäts-Gesellschaft, [illegible] the [illegible] (Carl Schwarm Ges.), and one patent of the [illegible] Meister, Lucius & Brüning.

LIQUIDATION.

[illegible] British Continental Electricity Co. [illegible] the liquidator, Mr. C. E. Barker, 9, Finsbury-pavement, London, E.C. 2.

CATALOGUES, &c.

[illegible]

"One Part" Holder.—Messrs. Tredegars (Ltd.), 9, Diana-place, [illegible]

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Bath.—[illegible]

Birmingham.—[illegible] th £507,503 in previous year). [illegible] gross profit £224,724 (£191,284), out o[illegible] rs' deposits £144 (£111). [illegible]

Newcastle-on-Tyne.—[illegible] or £154,619 (£135,764) after adding [illegible] rates, and £2,065 set aside for [illegible]

Sheffield.—[illegible]

Wednesbury.—[illegible]

COMPANIES' MEETINGS AND REPORTS

Eastern Telegraph Co., Ltd.

[illegible]

which we are working, it is [illegible]

while £41,000 more was d[illegible]

for the year 1916, £1,459,34[illegible]

referred, we have been able to make a [illegible] general reserve fund, while maintaining the prev[illegible] bonus of 8 per cent., free of income tax, on t[illegible] company, and to carry forward £54,688, an incr[illegible] corresponding figure of 1915. The Board has [illegible] augment the fund set aside on account of invest[illegible]

[illegible] possible cash surplus for the current year of 1917, and we now hold on account of the general reserve fund £1,700,000 of the [illegible] House is about six million pounds. Notwithst[illegible] traffic which we have carried during the year [illegible] efficiency as hitherto, and we are justly [illegible] messages of the general public. [illegible] principal factors which have cau[illegible] to India, and also the reduction in the [illegible] communication. [illegible]

instead of a[illegible]

Eastern Extension Australasia & China Telegraph Co. (Ltd.)

The 83rd ordinary general meeting was held on Tuesday, under the presidency of Sir John Wolfe Barry, K.C.B., the chairman of the company.

The GENERAL MANAGER AND SECRETARY (Mr. F. E. Hesse) having read the notice convening the meeting, &c.,

The CHAIRMAN said: Gentlemen, before entering upon the details of the Company's operations for the past year, I wish to express the Board's regret that, owing to circumstances beyond their control, they were unable to hold the annual general meeting as usual in the month of May. The company was unable to obtain the necessary data from other telegraphic administrations to enable them to complete the accounts for audit, and this delay continued until quite recently. It did not, however, prevent the distribution amongst the shareholders, at the usual time, of the final dividend and bonus for 1916, as the Board considered, from the estimated figures then before them, that they would be justified in paying 6 per cent. and the usual bonus of 2 per cent., free of income tax, without waiting for the shareholders' approval, and the audited accounts now presented to the shareholders show that our views were correct. Turning to the printed accounts—which I think you will agree are very satisfactory—it will be seen that the gross receipts for the year 1916 amounted to £1,221,000, against £950,000 for 1915, an increase of £271,000, which is due to development of traffic all over the company's system, including the important local traffic between India and China, Japan, Straits Settlements, &c. The working and other expenses amounted in round numbers to £430,000, against £386,000 for 1915, showing an increase of £44,000, which is practically accounted for by the heavier cost during the past year of cable maintenance, staff salaries, war payments, overtime, &c., as compared with the previous year. Included in this debit is this company's proportion of the further contributions made by the Associated Cable Companies to war relief funds during the past year, which I have no doubt will meet with the same warm approval of the shareholders as at previous meetings. After deducting from the increased earnings the additional working expenses, there remains an increased net revenue for 1916 of £227,000. Out of the balance of £791,000 provision has been made for the payment of interest on the 4 per cent. mortgage debenture stock, amounting to £30,096; for excess profits duty and income tax payable in England, amounting to £246,000; for the dividends and bonus already paid, amounting to £240,000; as well as an increased contribution of £250,000 to the general reserve fund. The balance of £63,000 has been carried forward, against £38,000 for 1915. The shareholders will have seen from the printed report that the agreement entered into by the French Government with the Company in 1884 for providing and maintaining, under a subsidy arrangement, cable communication [illegible] Cochin China and Tonquin has expired, and the cable has been sold and formally transferred to the French Government. After crediting capital expenditure with the cost of that cable (£121,454), which was originally debited to that account, the loss [illegible] amounting to £66,153, has been debited [illegible] fund. You will also have seen from the report that, under arrangements made with the Governments of the Australian [illegible] and New Zealand, the company's cable stations at La Perouse (near Sydney) and Wakapuaka (near Nelson) have been closed, [illegible] between Australia and New Zealand extended to Wellington, where they are now being worked direct with Sydney under [illegible]. The cost of the extensions and partial renewals of these cables will be debited to the general reserve fund for [illegible] I have entered so fully into the effects of the [illegible] Associated Cable Companies that I need not now [illegible] that the work has been well [illegible] by the satisfactory financial results now placed before you. In the early stages of the war the com[illegible] of the staff eligible for military service [illegible] technical men had to be retained [illegible] its usual [illegible] men would naturally have pre[illegible] but with a very few excep[illegible] and the largely increased [illegible] under the difficult conditions created by the [illegible] concerned. The chairman concluded [illegible] that the report and accounts be adopted.

[illegible] seconded [illegible] question had been answered it was [illegible].

[illegible] and the Hon. [illegible], the retiring directors, [illegible] and Messrs. [illegible] Pender, Griffith & [illegible] re-elected auditors.

[illegible] directors and the whole of the [illegible] the past year terminated the proceedings.

CLAUD HAMILTON (LTD.) [illegible] report for the year ended April 30 [illegible] profit and [illegible] including [illegible] the usual depreciation, [illegible] dividend, the balance [illegible] per cent. and a bonus of [illegible] account [illegible]

DICK KERR & CO. (LTD.) [illegible] during the 12 months [illegible] and there has been reserved the sum required to provide for the premium payable on the redemption of the present debenture stock. These items absorb £10,488, leaving £105,374 available for paying the dividend of 6 per cent. per annum on the preference share capital (£18,300), a dividend of 10 per cent. per annum on the ordinary share capital (£26,000), and to supplement special reserve for contingencies by £25,000, leaving £36,074 to carry forward. Although the amount of excess profit levy under the Munitions of War Act has not been finally settled, the directors believe that the reserves which they have made in the accounts for extra depreciation, special taxation, &c., are sufficient, and they therefore feel justified in recommending the payment of a dividend on the ordinary shares as indicated above. During the year the work carried out by all departments on behalf of the Government has been of even greater magnitude than in the preceding year. The national factory has been completed and organised, and was handed over to the Government as a going concern in July last, thus releasing a number of the members of the staff for new development work in other directions. The company has acquired the control of the United Electric Car Co. by the purchase of the greater part of its issued preference and ordinary shares. The directors intend to dispose of their preference shares in the Car Company, as under the amended articles of association Messrs. Dick, Kerr & Co. retain control of the Car Company by holding the ordinary shares. The works of the Car Company adjoin the company's own works at Preston, and can be conveniently operated under one management. The output will be sold through Dick, Kerr & Co.'s selling organisation.

ERINOID (LTD.)—At the meeting last week the chairman (Mr. A. Binnie) said the directors were able to declare a dividend at the rate of 7½d. per share (tax free), which was equivalent to 16¼ per cent. per annum. The profit was double that of 1916 and was due to the normal growth of a new industry. Referring to the excess profits duty, he said that from the point of view of new industries it operated as protection in its most objectionable form. For a new industry there was no incentive for development, while it was impossible to accumulate the necessary working capital.

HURST, NELSON & CO. (LTD.)—For the year ended July 14 the profits were £78,770, against £73,426. After paying income tax and interest, and allowing for depreciation on works, &c., the balance brought forward was £67,079, against £60,689. After placing £20,000 to general reserve, a dividend at rate of 10 per cent., and a bonus at the rate of 2½ per cent., (tax free), are recommended, the same as a year ago.

NORTH METROPOLITAN ELECTRIC POWER SUPPLY CO.—At an extraordinary general meeting last week a resolution was passed to the effect that of the amount which the company were authorised to borrow on debenture or mortgage of the undertaking, a sum not exceeding the nominal amount (inclusive of bonus) of £13,333 be raised by the issue of further mortgages in like form and on like terms as and ranking pari passu with the existing mortgages. The chairman (Mr. E. Garcke) explained that the object of the resolution was to enable the directors to provide security to be deposited with the Treasury in respect of loans for carrying out extensions of cables and for other works to enable supplies of energy to be given to manufacturers, &c.

ROYCE (LTD.)—The report for the year ended March 31 shows a profit after providing for the estimated amount payable for excess profits, and including £2,957 brought forward, of £10,421. The directors recommend a dividend of [illegible] per cent., tax free, the same as for the previous year, and they propose to apply £5,000 in reduction of goodwill, leaving £224 to be carried forward.

CITY NOTES.

AMALGAMATED ZINC (DE BAVAY'S) (LTD.)—A dividend of 1s. per share has been declared.

ANGLO AMERICAN TELEGRAPH CO. (LTD.)—The directors have declared an interim dividend for the quarter to Sept. 30 of 15s. per cent. on the ordinary stock and £1 10s. per cent. on the preferred stock (less tax), payable on Nov. 1.

ANGLO-PORTUGUESE TELEPHONE CO. (LTD.)—The directors have declared an interim dividend of 3 per cent. (less tax) on account of next year to Dec. 31, 1917.

KAMINISTIQUIA POWER CO. (LTD.)—The directors have declared a dividend of $1¾ per share, or at the rate of 7 per cent. per annum for the quarter to Oct. 31.

LIMA LIGHT, POWER & TRAMWAY CO.—The directors have declared a dividend of [illegible] per cent. in Lima on the shares payable against coupon No. 14 in London by Messrs. Grace Bros. & Co., 144, Leadenhall-street, E.C.

MANORHAMILTON ELECTRIC LIGHTING CO. (LTD.)—The directors have appointed Mr. [illegible] as secretary of the company.

MONTREAL LIGHT, HEAT & POWER CO.—The directors announce a dividend of 2 per cent. on the paid-up capital stock (being at rate of 8 per cent. per annum) for the quarter to Oct. 31.

ROBEY & CO. (LTD.)—Mr. Thomas Manton Allan has been appointed to a seat on the board of the company.

WESTERN TELEGRAPH CO. (LTD.)—The directors have declared a dividend of [illegible] per share and a bonus of [illegible] per share, both tax free, making, with previous dividends, a total distribution for the year ended June 30, 1917, of 8 per cent. For the purpose of paying the above dividend and bonus on Nov. 8, the register of transfers will be closed from Oct. 30 to Nov. [illegible] inclusive.

THE ROUND TABLE.

By "KVA."

[illegible]

* * * *

[illegible] has nothing to do with the fusing of electric wires!

* * * *

[illegible]

[illegible]

* * * *

[illegible] chief plank in his platform is [illegible]

* * * *

[illegible] tells me that the native is [illegible]

THIRTY-SEVEN YEARS AGO.

[illegible] premises.

[illegible]

State Power Supply. [illegible] would give to the State a direct [illegible] the original outlay of £7,000,000 [illegible] ployed in the production of elect[illegible]

Electric Steel Manufacture in Denmark. [illegible] At the outset the new undert[illegible]

The Electric Steel Furnace in Japan. [illegible]

Patent Legislation. [illegible]

Education. [illegible]

OIL-BREAK SWITCHES.

The British Thomson-Houston Co. (Ltd.), of Rugby, have recently issued lists Nos. 4,153 and 4,155, giving full particulars of their oil-break switches, type O, forms C and E.

The switches illustrated and described in the first-mentioned list are suitable for controlling circuits up to 300 amperes at 3,300 volts. They

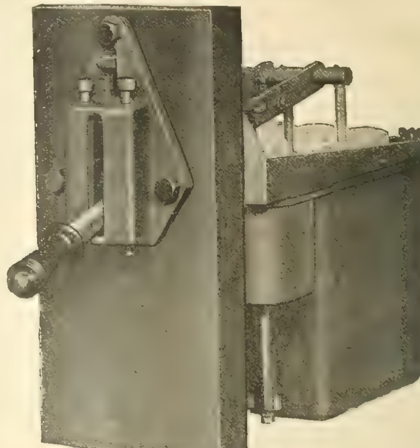

FIG. 1.

can be supplied with non-automatic mechanism, overload trip mechanism and low-voltage devices. The rating of the automatic switches is determined by the winding of the trip coils, the switch proper in every case being suitable for 300 amperes, so that switches of the smallest

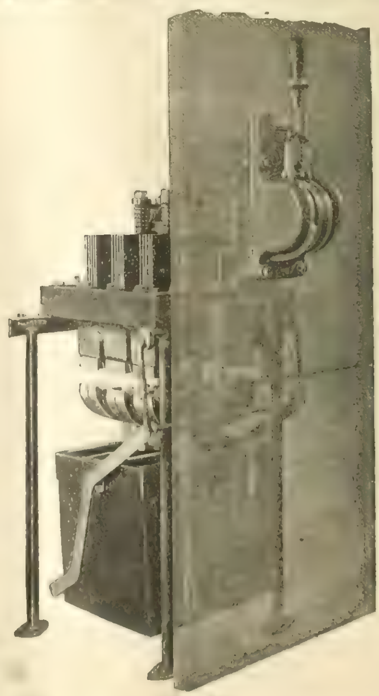

FIG. 2

ratings have substantial contacts. The switches are closed by pushing the operating lever downwards and are opened by pushing the tripping lever downward. The tripping mechanism is of the free handle type, is arranged so that the switch cannot be held closed on a fault, and comes

into operation immediately contact is made and before the handle is fully closed. An indicator shows when the switch has opened automatically. The switches open by gravity when the catches are released, and the action when opening is quick and positive, a double break of ample length being obtained. The oil vessel, trip coils and operating mehanism are all supported on a common frame ; all live parts are supported on porcelain insulators, and the trip coils are insulated with varnished cambric, and impregnated by a special process. Switches can be provided with one-coil, two-coil or three-coil overload trips. The overload release coils are of the series type. In cases where the switches are to be operated by reverse relays d.c. trip coils can be provided, and trip coils for operation from current transformers can also be provided. Switches with overload devices can also be fitted with a low-voltage release. Standard switches are constructed for mounting on a 2 in. panel, and are arranged so that the same fixing bolts hold the switch and escutcheon in position. The single-pole switches can al o be supplied suitable for bolting to the face of a wall. These switches are equipped with special operating mechanism.

Switches of type O form E are designed for use on heavy a.c. three phase circuits up to 600 volts ; they are suitable for mounting on switchboard panels 2 in thick, the switch body being mounted on the back and the switch operating handle on the front of the panel. These switches are made in two sizes, rated respectively 2,000 and 3,500 amperes, these being continuous ratings at 50 cycles or less. The oil tank, contacts and operating mechanism are all mounted on a carefully selected and impregnated slate base, fixed to the back of the panel, and supported from the floor. Contact is made by laminated brushes bearing on solid copper blocks, and the contacts are designed to utilise to the full the strong magnetic field surrounding the heavy current carrying parts. The trip coils are at the back of the panel, being mounted on the switch body frame, and all switches with overload trip coils are provided with B.T.-H. time limit fuses, giving a wide range of adjustment for time and current. The switch operating mechanism is of the free-handle type, and can be supplied either with or without automatic trip. Fig. 1 shows a triple-po'e O.C. oil switch, with overload and low-voltage release, the switch being in closed position, while Fig. 2 is a 3,500 amp. O.E. oil switch, the switch tripped and oil tank lowered.

THE "ELECTRIC" IN COAL MINES.

"Fuel oil is going to be less and less a competitor of coal in the far West," states the "Coal Age." "The wells in California are fewer in number and shorter lived than was expected. More by-products are being obtained from crude oil than in the past, and this development is likely to continue even after the war ends. The result is going to be very high prices for what fuel oil is available. The action of one great railroad in forsaking oil and returning to coal is but the fore runner of similar action on the part of many other railroads and industrial plants.

An investigation by Mr. Floyd W. Parsons shows that about 1,100 new coal mines have been opened in the United States in the past 15 months, and the question of labour is at present the chief problem of the coal industry. Forty million men have been drafted from productive life and put to the business of making war. At least three men at home are required to devote their energies to supplying the needs of every actual fighter with food and weapons of destruction ; which means we have turned the efforts of nearly two hundred million men to destroying civilisation rather than to the attainment of any useful ends. No wonder the cost of food has gone up even in China and far-off India. If the war is to continue, we in America must now withdraw our quota of men from useful occupations. If we are to do as well as Canada, and no better, we must send more than 3,000,000 soldiers to Europe, for we have 13 times the population of Canada." One of the ways which Mr. Parsons suggests to meet this labour problem is to introduce machinery and labour-saving devices. The electric industrial truck and the storage battery locomotive meet this emergency in a satisfactory manner.

Storage battery locomotives are being used both for gathering service and for main haulage. As one of these "electrics" will do the work of three to eight mules, it displaces a large number of drivers who can be more profitably employed at the coal face. The cost of hauling coal

and ore with storage battery locomotives is only about one-half what it costs to haul with mules or horses, and the mine output can be materially increased and the sanitary conditions improved by the use of this electric vehicle. The Electric Vehicle Section of the National Electric Light Association has collected some interesting data showing the actual savings of the miniature electric locomotives over mule haulage in mines.

The Madison Coal Corpn., strongly advocates the use of the electric locomotive in coal mines, based on actual operating experience, states that, in addition to the money saving in ton haulage, there is a remarkable financial economy in the prevention of injuries, for while their mule drivers form only 5 per cent. of their entire working forces, their accidents amount to 26 per cent. of the whole number, and the cost in connection with them amounts to 34 per cent. of the total liability cost. Some comparative monthly operating costs of the Madison Coal Corpn. are given. The cost of gathering coal with storage battery locomotives for one month as compared with mules (reckoning that the "electric" displaces four mules) is as follows:—

Four Mules.

Feed and feeding	\$69·44
Four drivers (162 hours each)	230·04
Blacksmithing for four mules	3·84
Depreciation (life of mule five years)	14·28
Veterinary and medicine	3·60
Harness	3·60
Driver boss	18·00
Total cost	\$342·80
Tonnage gathered with four mules during one month = 8,368 tons.	
Cost to gather with mules and drivers	\$0·04096

Storage Battery Locomotive.

Maintenance cost of batteries	\$30·00
Maintenance cost of mechanical equipment	12·50
Motorman (162 hours)	68·44
Trip rider (162 hours)	57·51
Charging batteries, 20 hours, one hour each night mine work	6·55
Oil	0·20
Cost to maintain locomotive	\$175·70
Tonnage gathered with locomotive = 8,900 tons.	
Cost to gather with locomotive	\$0·01974
Current (73 kw. at \$0.1½ per kilowatt	0·00125
Total cost to maintain and gather with locomotive	\$0·02099
Cost to gather with mules, per ton	\$0·04096
Cost to gather with locomotive per ton	0·02099
Difference in favour of locomotive	\$0·01997

The Pocahontas Smokeless Coal Co., of West Virginia, is also successfully operating storage battery locomotives. At their mine four cars each weighing 1,300 lb. empty, and 4,100 lb. loaded, are hauled on each trip by one electric storage battery locomotive, on main entry, a distance of about 2,500 ft. including 1,200 ft., against 3 per cent. grade, 400 ft. against 2½ per cent. grade and short grades of 5 and 7 per cent. all against the loads. To secure the 400 tons a day that this mine should produce the mule haulage would cost \$735 a month and battery haulage \$306 a month, making the very substantial saving of \$429 a month in favour of the "electrics." Furthermore, the maximum number of mules and cars allowed by the track conditions could not handle 400 tons a day. The upkeep on ties and track was quite considerable with the mule haulage, and is greatly reduced with the locomotives. It is estimated that in one year the "electrics" will save the capital cost of the whole installation and at the same time increase the coal output by at least two-thirds.

FUEL ECONOMY IN SCOTLAND.

In a recent issue of the "Scotsman" Mr. H. J. Peddie, dealing with the conservation and utilisation of the national coal supplies, points out that the Lothians area is most admirably adapted to become the centre from which "electric irrigation and gas-power irrigation" could be most advantageously and economically spread over a large part of Scotland, to the great benefit of existing and future industries. The area, if judiciously and systematically exploited on scientific lines, would become in the future "Scotland's national power-house and laboratory."

The demand for electric energy and gas for power is ever increasing, and presents an admirable field for commercial enterprise and scientific development. As an example of "electric irrigation," although only on a small scale, he cites "the Societé per l'Utlizzazione di Combustibili Italiana," at Orentana, in Italy. The plant of this company is placed at the side of a great bog, and gasifies and recovers the by-products from 210 tons of air-dried peat daily (24 hours). Its capacity is over 3,000 H.P. and the current is distributed over an area of about 25 miles radius, at a tension of 30,000 volts. "With its vast stores of first-class gas coal, what could not the Lothians area achieve in 'electrical irrigation of industries,' and would it not every way be an infinitely more national and beneficial way to use our own coal supply to attract new local industries and foster them and existing industries than fatuously to export it wholesale, for the benefit of our industrial rivals, of whose methods and aims we of late have had such painful experience."

THE ELECTRICIAN:

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CONTENTS.

NOTES.

The Tungsten Lamp Litigation.

THE tungsten lamp continues to be a source of much litigation, even in these times of national stress, from which it follows that large financial interests are at stake. The present incident closes the case brought by the Osram-Robertson Lamp Works against Pope's Electric Lamp Co. for infringement of the Just and Hanaman patent. Broadly speaking, the main distinction between the two processes is that, according to the patent, the [illegible] filament is heated by an electric current in an atmosphere of [illegible] and hydrogen, thus completely [illegible] any carbon and reducing any oxides of tungsten, so that a filament of the metal alone remains. The process followed by Pope's Electric Lamp Co. differs from this in that the filaments are heated [illegible] and an atmosphere of steam and hydrogen is not used. The plaintiffs, however, contended that such an atmosphere was, in effect, produced by the decomposition that took place in the filament, and this view has now been supported by the House of Lords. We must confess [illegible] doubt as to the accuracy of this view, for [illegible] steam and hydrogen [illegible] would have to be produced by the decomposition [illegible] producing the [illegible]. [illegible]

Such, however, are the [illegible] of war in patent litigation, and these uncertainties must arise so long as patents form the basis of our industries.

The Dover Tramway Accident.

AN unfortunate accident occurred recently at Dover attended by serious fatal consequences. The Dover tramways are characterised by some rather steep gradients, one of those leading over the summit of Crabble Hill. The car [illegible] and was taken by the driver up to the top of the hill without any unusual occurrence. Having passed the summit, he tried to stop the car at the compulsory stopping place with the hand brake. This he was unable to do. He states that he also attempted to use the slipper brake and the electric brake, but without effect. The car rapidly gained speed, and although it negotiated one curve successfully it was derailed at the second curve and fell over. Col. J. W. Pringle, of the Board of Trade, in his report, which we give elsewhere, came to the conclusion that the driver lost his head when he found that he could not draw up at the compulsory stopping place. This is not [illegible] when we learn that the driver was recently discharged from the Army [illegible] and [illegible] after nine days' training on the tramways he was put to work as a regular motorman on August [illegible], the accident occurring on August [illegible]. That a man with this short experience should be entrusted with the [illegible] shows that those responsible for [illegible] the tramways do not realise the qualities that are necessary for the safe handling of [illegible]. We think that Col. Pringle's recommendation that only motor drivers with [illegible] experience should be permitted to work the traffic on Crabble Hill [illegible] will be endorsed by all who are familiar with the dangers of tramway [illegible]. [illegible] off the power. No driver is safe unless he [illegible] does what is [illegible] in an emergency. [illegible] In other words, safety can only be obtained by [illegible] and [illegible] drivers of [illegible].

Street Lighting in the United States.

[illegible]

between the conditions here and in the United States. In that country there is apparently little fear of air raids, so that the only inducement to diminished public lighting is the question of economy. On the other hand, in many important areas the amount of illumination has been very considerably increased, the extra lighting being intended as a measure of safety to prevent any possible prejudicial action near bridges, &c., by hostile aliens during the night. Nevertheless it seems only natural to expect that, with the increasing strain of war and the progressive shortage of labour there may be curtailments in the public lighting of the less important streets in the future, as well as a disposition to postpone new developments on a large scale.

Extensions at Leeds.

In a report to the Electricity Committee at Leeds, the city electrical engineer, Mr. C. Nelson Hefford, advocates very considerable extensions. The scheme is by no means new, having been considered in 1914, and it is a little surprising that the undertaking has not found it imperative to put extensions in hand somewhat earlier. It appears, however, that Leeds has not been met with such a rapidly increasing load as many of our other cities. The normal load for last winter may be taken as 22,255 kw. Judging by the past, Mr. Hefford concludes that the maximum demand will be 31,500 kw. in 1918-19 and 42,000 kw. in 1921-22. We certainly hope that the growth will be considerably more rapid than this. We are inclined to think that electrical engineers are under-estimating the rapidity with which our supply undertakings will increase in the near future. Be this as it may, it is proposed to obtain permission to put down a 12,000 kw. turbo-alternator with corresponding boiler plant, and also to replace two 1,400 kw. reciprocating engines and alternators by a 6,000 kw. turbo-alternator. It is a little surprising to find reciprocating plant of this size still in use in a city like Leeds. Such plant is practically obsolete, requiring 24 lb. of steam per kilowatt-hour, and the annual saving by using more economical plant will be £900. We hope that the time is not far distant when antiquated plant of this kind will not be found in any undertaking serving our large cities, for it can only prove to be a handicap.

Royal Society. Among the papers read at the meeting held yesterday was one by the Hon. R. J. Strutt, F.R.S., on the [illegible] of Luminosity of Electric Discharge in Gases and Vapours.

Royal Society of Edinburgh. At the recent annual meeting Dr. J. Horne was elected President for the ensuing year. The general secretary is Dr. G. C. Knott; the secretaries of ordinary meetings are Prof. A. Robinson and Prof. E. T. Whittaker, and the treasurer is Mr. J. Currie.

The Longest Telephone Line in the World.—It is stated that the [illegible] line put in service by the Bell Co. a few [illegible] between Montreal and Vancouver is the longest in the world. The distance is over 4,000 miles, and exceeds that of the New York–San Francisco line, which was previously considered to be the longest [illegible] in service.

Important Submarine Cable Concession.—The Brazilian Government [illegible] Western Telegraph [illegible]

Substitution of Aluminium for Copper in Switzerland.—A [illegible] countries, has been endeavouring to use aluminium to replace copper for electrical conductors. Arrangements have been in progress for combined action in regard to the importation of copper, but with a view to securing alternative supplies of aluminium an inquiry on this subject was addressed to the central stations, 13 of which made a total demand for 70 tons of the metal. Apparently, however, there are other demands for aluminium, or difficulties in its production, for the association, at the time of the report, had only succeeded in getting delivery of 10 tons.

Electricity and National Welfare.—A series of three lectures under the above title and dealing respectively with (1) Electricity and the Improvement of Town Atmosphere, (2) Electricity and Increased Food Production, and (3) Electricity and the Hygiene of the Body, are to be delivered in the Museum Lecture Hall, Leicester, by Mr. H. T. Davidge, Professor of Electricity at the Ordnance College, Woolwich, on Nov. 17, 24, and Dec. 1 respectively, at 7.30 p.m. These form part of the Chadwick Public Lectures for the current session, other subjects of interest being "The Part of Hygiene in the European War," by Dr. Woods Hutchinson, and "The Powers of Man as a Worker," by Prof. Henry J. Spooner.

Recent Mineral Discoveries in Canada.—There seems no end to the series of valuable mineral deposits that are being located in Canada. The "Journal of the Society of Arts" states that practically inexhaustible deposits of manganese peroxide have been found near South-East Albert. Eight hundred million tons, valued at £11,000,000, have already been blocked out. As is well known, this material is widely used for the toughening of iron and steel, as well as for war munition purposes. The announcement is also made that the Department of Mining of the University of Toronto has discovered a process by which low grade concentrates of molybdenite can be made at low cost. The new process will, it is hoped, render available the low-grade deposits of molybdenite recently discovered in Manitoba and British Columbia.

Electric Vehicles for Postal Service.—According to the "Electrical Review and Western Electrician," electric trucks are being very successfully used by the United States Postal Department in several large cities. St. Louis has a fleet, which are in service from 5.45 a.m. to 11.30 p.m., and average 30 miles each day; and the 15 trucks used in Boston make runs of 25 miles a day, and are stated to have brought about substantial savings as well as greater efficiency in handling the mail. The largest fleet, however, appears to be that of the New York Postal Transfer Service, which comprises 47 electric trucks. These have been in service for three years, and are on duty for two 10-hour periods each day. The electric vehicle finds special applications in this service which involves the speedy and safe negotiation of congested traffic.

National Physical Laboratory.—We have received a copy of Vol. XIII. (1916) of the "Collected Researches" of the National Physical Laboratory, containing reprints of a number of Papers and two Papers which have not already appeared in other publications. These latter are a Paper on "Constructional Data of Small Telescope Objectives," by Mr. T. Smith and Mr. R. W. Cheshire, and a report on "Tests of Fuel Oils carried out for the Royal Commission on Oil Fuel, June, 1914," Part I. being by Mr. J. R. Pannell and Part II. by Mr. W. F. Higgins. Among the republished Papers we notice Mr. Albert Campbell's I.E.E. Paper on "The Magnetic Testing of Bars of Straight or Curved Form," and a Paper by Mr. F. E. Smith on "The Manufacture and Testing of Prismatic Compasses, especially Mark VIII., Military Pattern."

The Penetration of Light in Selenium.—It has been a matter in dispute for some years whether the action of light on selenium is essentially a surface phenomenon, or whether there is any effect of penetration, in which case the thickness of the selenium film would have a material influence. This question is discussed by W. S. Gripenberg in the "Physikalische Zeitschrift." Working with a selenium film 0.05 mm. in thickness, he [illegible] the effect of light on resistance, firstly, with the two electrodes applied to the film side by

side: secondly, with the electrodes applied to opposite faces. He then found that the increase in conductivity under the action of light was 1·5 times as great in the second case as in the first. The conclusion he draws is that the light affects the interior of the selenium as well as the surface, *i.e.*, thickness of material is an influential factor.

Mechanical Transport of Letters in the Paris Post Office. – In 1913 a report was presented by M. Tongas, chief engineer of the French Postal Service, on the use of mechanical transport in the G.P.O. in London. According to the "Annales des Postes, Télégraphes et Téléphones," a similar machine was in operation at the end of last year at the chief Post Office in Paris, and is working quite satisfactorily. The object of the machine is to facilitate stamping of letters, which are caused to travel round a circular table at the rate of slightly under one metre per second, coming under the stamping machines as they pass round. In the centre of the table is a second movement on which all parcels, &c., unsuitable for mechanical stamping are placed, and which shoots them into baskets whence they are taken and stamped by hand. Power is provided by a 0·6 H.P. 110 volt motor, operating at 2,000 r.p.m., the speed of which is controllable from beside the stamping machines.

British Standardisation Rules for Electrical Machinery.—We have received from the Engineering Standards Committee a copy of the new edition of the British Standardisation Rules for Electrical Machinery (excluding motors for traction purposes). This is the first of the Committee's publications to be issued at the uniform price of 1s., and we notice that a more convenient size of page has been adopted. French, Italian and Spanish translations of this report will be available shortly. It is to be hoped that engineers will take advantage of these new facilities.

The principal modifications introduced during this revision of the Rules are as follows:—

The permission to use the thermometer method of measuring the observable temperature of continuous-current shunt wound stationary field coils provided the makers can show that if the resistance method had been employed the limits of observable temperature and observable temperature rise permitted by the rules would not have been exceeded. The thermometer method is in this case penalised with a 5 deg. reduction in the permissible temperature limit.

In the first edition of these rules the use of embedded temperature detectors was permitted for large machines, but in the present rules measurements made with embedded temperature detectors are no longer [illegible]

[illegible]

Municipal Association of Electrical Engineers (Union of South Africa). [illegible]

[illegible]

On Wednesday [illegible] of the Mayor [illegible] ing lecture was [illegible] Mr. J. W. K[illegible], burg, on railway [illegible] Milwaukee & St. Paul Railway [illegible] being to show how electrification could be advantageously adopted in South Africa.

On Thursday a Paper on [illegible] was read by Mr. [illegible] Roberts, and the discussion led to some important recommendations being arrived at for submission to the South African Standards Committee now sitting in Johannesburg. In the evening, by the invitation of the Engineering Section of the Natal Society for the Advancement of Science and Art, the members of the convention attended the first annual dinner of that society, and there were about 100 present. On Friday further discussion took place on tariffs, and important resolutions were adopted for circulation among all South African municipalities. The appropriation of net profits from undertakings to the relief of rates was very strongly condemned. A Paper was also read by Mr. E. J. Hamlin on "The Design, Operation and Management of Small Electric Power Stations."

OBITUARY.

L. FLOERSHEIM.—We regret to record the death, in his [illegible] year, of Mr. Louis Floersheim, which took place on the 26th ult. For some years Mr. Floersheim was a director of The Electrician Printing & Publishing Co., and took considerable interest in the fortunes of this journal. Mr. Floersheim was a well-known figure in the City and was regarded as a high financial authority.

DEATHS ON ACTIVE SERVICE.—The following deaths are reported:—

Second-Lieut. K. L. James (the Buffs), 29 years of age, who was killed in May last, had taken a first class in electrical engineering at the City and Guilds Engineering College, and prior to the war was in the service of Callender's Cable & Construction Co.

Second-Lieut. L. Fleet (R.F.C.), aged 22, was killed in a flying accident on Oct. 27. In civil life Mr. Fleet was an electrical engineer.

Corp. Geo. Wheldon (London Regiment), formerly in the India Rubber Co.'s London office, was killed on Oct. 1.

PERSONAL.

The Mayor of Eastbourne has presented Mr. R. Torpy, borough electrical engineer of Tunbridge Wells, with a Royal Humane certificate for gallantly rescuing a bather.

WAR HONOURS.—The following award is announced:—

Second-Lieut. H. F. Gill (R.E. Wireless Section), formerly of the [illegible] department [illegible] the Military Medal conferred upon him in 1916, and who has recently been wounded in France, is now convalescent in London, and has been awarded the Military Cross.

The Military Medal has been awarded to Rfmn. T. Barnett (London Regt.), formerly in the India Rubber Co.'s electric light department, for carrying [illegible] Sept. 20.

WAR CASUALTIES.—[illegible]

[illegible] been wounded [illegible]

Pte. A. W. M[illegible] light department, has been wounded.

ARRANGEMENTS FOR THE WEEK.

TUESDAY, Nov. 6th.

[illegible]

WEDNESDAY, Nov. 7th.

[illegible]

THURSDAY, Nov. 8th.

[illegible]

A STUDY OF ELECTRIC FURNACE OPERATION.*

BY F. T. SNYDER.

The financial man responsible for the operation of an electric steel furnace finds that there are six items of expense :—

1. The cost of electrodes.
2. The cost of refractories.
3. The cost of electricity.
4. The cost of labour.
5. The charges for maintenance, depreciation and interest on the original investment.
6. The cost of raw materials.

This last item of raw materials is practically unaffected by the type of furnace construction, or the form of current supply, as long as the furnace is reasonably well operated, and can therefore be left out of further consideration.

THE COST OF ELECTRODES.

Each electrode in a furnace costs the user in two ways. The electrode gradually burns up and involves a cost per pound of electrode. The electrode also conducts heat out of the furnace. This heat has to be paid for at a kilowatt-hour rate. The sum of these two items constitute a charge per hour of furnace operation, and if the furnace is operated at a constant rate they constitute a charge per ton of product. For a well-designed furnace melting 1,000 tons of steel a month, these items constitute a charge of some $6,000 a year *per electrode*. It is quite evident that reducing the number of electrodes is something that warrants serious consideration. With capital worth 20 per cent. a year the elimination of one electrode on such a furnace would justify an investment of $30,000.

The ideal furnace would have no electrodes. The induction furnace met this requirement, but unfortunately the induction furnace had inherently two defects. One was electrical. To act as a short-circuited transformer secondary, the furnace had to be built in the form of an open ring. This greatly increased the radiation surface. The other defect was metallurgical. The energy was developed in the metal and the metal was, therefore, hotter than the slag. This reduced the speed of the chemical reaction by which the impurities of the steel were transferred from the metal to the slag. Together these two defects so reduced the speed and increased the cost of melting per ton of steel that the operating cost of an induction furnace became commercially prohibitive, as compared with arc furnaces of all types. In addition, the electrical limitation of the furnace design caused by combining the transformer with the furnace forced the use of low frequency, 5 to 10 cycles, which in turn required special sub-station equipment and resulted in an investment per ton of product more than double that required for arc furnaces.

As the use of no electrodes has proven to be commercially impractical, the minimum number that may be used is one. By using the metal bath in the furnace as one terminal of the arc, a furnace can be operated with one electrode per arc, one side of the circuit being connected to the electrode, the other side to the molten metal bath. The contact between the electric circuit and the bath is permanent and has a heat-loss cost below one-tenth of that of the operating [illegible] second electrode. If one electrode with [illegible] or two electrodes with two arcs in series are used, [illegible] that the current supply must be single phase or direct current.

As three-quarters of the large total cost per year of each electrode [illegible], it is evident that the smaller the surface, that is, the smaller the electrode, the lower will be the electrode cost. The size of the electrode is determined by the number of amperes of current which it has to carry. The power input into the furnace [illegible] volts. The amperes of current and, [illegible] of the electrode, will be smaller, the [illegible] electrode and metal bath. The voltage [illegible]

[illegible]

to the bath. The surface of the two electrodes exposed to burning is double that of the single electrode. The equivalent cost of the two electrodes with two arcs in series, on the basis of 1,000 tons of steel a month, is therefore $13,500 a year as compared with $7,500 a year for the one electrode and its contact.

If three electrodes are used through the same roof, so as to introduce directly three-phase current into the furnace, the limiting potential between electrodes is in usual practice kept at about 110 volts. Due to the phase relations of the currents in the three electrodes this result in a potential between each electrode and the bath of about 65 volts. With the same total input each electrode of the three will carry one-third the energy carried by a single electrode, at about one-third the voltage. Therefore, *each* electrode of the three will carry the same current as does the single electrode and consequently will each be the same size, with a total of heat losses and surface burning equal to three times those of the single electrode. For 1,000 tons of steel per month the electrode cost for the three electrodes will be $18,000 a year as compared with a yearly cost of $7,500 for the single electrode and its contact.

THE COST OF REFRACTORIES.

In a well operated electric steel furnace the bottom and side walls are substantially permanent. The tendency of the bottom is to build up rather than wear away. It is the common knowledge of electric steel operation that the bulk of the refractory cost is due to roof wear and that the roof wears most around each electrode. In other words—the roof wear is substantially proportional to the number of electrodes. The combination of these facts may well be taken in corroboration of the cost figures from different furnaces showing a total refractory cost for three-electrode furnaces of substantially three times the total refractory cost for single-electrode furnaces. With a well-designed furnace melting 1,000 tons of steel a month this refractory cost may be kept down to $4,000 per electrode per year.

A further factor in the cost per ton of refractories is the fact that it is the maximum temperature at the end of the heat that wears the refractories in a steel furnace. As the roof walls and slag are near the same temperature the arc radiates to each about the same. Part of this energy is absorbed by and passes through the roof and wall. In a well-designed furnace this amounts to less than 10 per cent. of the total power input and consequently does not materially affect the wall temperature conditions. Of the energy radiated by an arc about one-half goes directly to the slag; the other half is reflected by the roof and walls. The roof and walls are, therefore, at a temperature between the temperatures of the slag and the arc.

In a steel furnace the temperature of an arc is not determined by boiling point of the carbon electrode, as gases from the metal and slag materials are always available to carry the arc. In a steel furnace the arc temperature is determined by the temperature the arc has to back up in order to radiate the amount of energy developed in the arc. The energy to be radiated per square inch of arc surface determines the temperature to which the arc must rise to get rid of energy at the input rate. If the arc is twice as long and remains the same diameter it will have twice the surface and radiate twice the energy at the same temperature, or will radiate the same amount of energy at a lower temperature. The current in *each* electrode of a three-electrode furnace is the same as the current in the single electrode of a one-electrode furnace. The diameter of each arc is therefore the same. The three-electrode arc voltage is 65. The single electrode arc voltage is 220. In each case about 35 volts are absorbed by the arc terminals. This leaves 30 volts per arc to determine the length of each of the three arcs of the three-electrode furnace and 185 volts for the single arc of a one-electrode furnace. Therefore the total length of the single arc is more than twice the sum of the lengths of the three arcs. As this single arc has consequently to radiate only half the energy per square inch, it will be cooler than any of the three arcs, as it does not have to back up so far to radiate its energy. As the arc is cooler, so will the walls from which its heat is reflected be cooler also. While this cooler temperature of the [illegible] high voltage arc does not amount to a great many degrees, the reduction in temperature comes near the melting point of the [illegible] of the roof and makes a large actual increase in the number of heats that the roof will last.

THE COST OF ELECTRICITY.

In melting [illegible] definite amount of energy is contained in the melted [illegible] poured into the ladle. The energy may be [illegible] expressed in kilowatt-hours. A second [illegible] in the [illegible] that [illegible] leaves the furnace [illegible] the melting of each ton. The sum of these

three items approximates 350 kw.-hr. per 2,000 lb. of steel. It is the object of an electric furnace to put these necessary three heat items into the furnace with as little loss or additional cost as possible.

In addition to these necessary heat items there are others that are direct losses. One is the radiation through the furnace shell the second is the heat loss through the electrodes. After the furnace is heated up these losses go on all the time whether the current is on or interrupted. In a furnace designed to produce 1,000 tons of steel a month these losses would be about 120 kw. continuously. If this furnace were given an energy input of 240 kw., after the heat losses were provided for only 120 kw. would be available for melting steel, at which rate it would take about 3 hours per ton melted. During this time 3 kw. × 120 kw. or 360 kw.-hr. of heat energy would be lost, making a total energy consumption of 350 kw.-hr. + 360 kw.-hr. or 710 kw.-hr. per ton of steel. If, on the other hand, this same furnace be given an energy input of 820 kw., the net energy available for melting after the losses were supplied would be 700 kw., which would melt the same ton of steel in a half-hour. During this half hour the heat losses would only be 60 kw.-hr., so that the total energy to melt would be 410 kw.-hr. per ton of steel. It is therefore apparent that the higher the input into a furnace the higher the heat efficiency. With a three-electrode furnace the limit is soon reached, as the electrodes become so large that there is not room enough on the roof to space the electrodes far enough apart to prevent current leakage through the roof. The electrical insulating qualities of the roof bricks can be increased by cooling them with water jackets. The heat loss to such water jackets, however, is much greater than the heat saved by the increased energy input or voltage rise made possible by the use of the jackets.

It is a common but mistaken idea that increasing the rate of energy input into a furnace makes the furnace necessarily operate at a higher temperature [illegible]. [illegible], the temperature in a furnace is deter- mined by the melting point of the material in the furnace and is practically uninfluenced by the rate of energy input, as long as there [illegible] to melt, provided there is at least enough energy input to take care of the radiation and other heat losses. This can be simply demonstrated by attempting to boil water containing ice. As long [illegible] the temperature will not [illegible] above the melting point of the ice. The energy is absorbed in changing the state of the ice instead of in raising its temperature. In the [illegible] steel [illegible] the furnace temperature cannot get above the melting point of steel, no matter at [illegible] energy [illegible] the furnace through the electrode.

With [illegible] to the rate at which [illegible] and the [illegible] taken. [illegible] requires time. The steel cannot be poured until it is substantially [illegible]

[illegible]

doors altogether. [illegible] furnace roof [illegible] of the furnace [illegible] patching was necessary. This method of charging the furnace has the additional [illegible] hold can be put in through the open roof, while with doors the scrap has to be [illegible] furnaces without doors and with lifting roofs have been running for two years, and it has been found that the heat loss in opening up the roof is [illegible] the absence of doors thoroughly protects the steel from oxidation from air, heats of steel can be de-oxidised as they are melted; that is, as soon as the [illegible] doorless furnaces no limit has yet been found to the rate at which they may be run. Steel heats from cold metal in one hour have proved entirely practical.

[illegible]

With an open-roof furnace the charging can be readily done with a bottom-dump bucket on a crane. Consequently, any sized doorless furnace can be operated by one melter with one helper. On furnaces outputting less than 500 tons a month no helper is needed. Such [illegible] ideal labour situation is the attribute of a single-electrode [illegible]. By having a single electrode a high voltage is possible. Th[illegible] a small current and a small, light-weight electrode. Such a small electrode can be operated readily by a simple hand-wheel. There being only one to adjust little of the melter's time is required. High voltage also saves electrode labour in another way. The 30 volts available for arc length [illegible] length of about $\frac{3}{4}$ in. The usual slag bubble rises about this distance, so each time a bubble comes up under an electrode the power load is short-circuited at the arc. With a single-electrode arc about 185 volts are available for arc length, which gives an arc about 5 in. long. The rising of a bubble $\frac{3}{4}$ in. under [illegible] consequently reduces the arc resistance less th[illegible] this reason the boiling of the bath is something th[illegible] any of the melter's time in a single-electrode furna[illegible] all the time of one man in a three-electrode furnac[illegible] this item three-electrode furnaces are frequentl[illegible] auxiliary for use under the difficult conditions in a steel plant and [illegible] labour item connected with electrodes is th[illegible] single-electrode hole through th[illegible] trodes that the labour item of [illegible] some $1,000 per year will be sav[illegible]

[illegible] precaution items are to [illegible] with a single [illegible]

SOME DETAILS OF CONSTRUCTION OF LARGE TRANSFORMERS BY THE BRITISH WESTINGHOUSE CO.

It is perhaps natural that the turbo-alternator should occupy the premier position in descriptions of electrical plant and that the transformer should be much less prominent for the former possesses all the inherent difficulties of rotating machinery, whereas the difficulties in so-called static plant are much more purely electrical. Nevertheless the large transformer presents many points of interest and some special problems of its own more particularly at the present time, when the size of the unit is being rapidly increased.

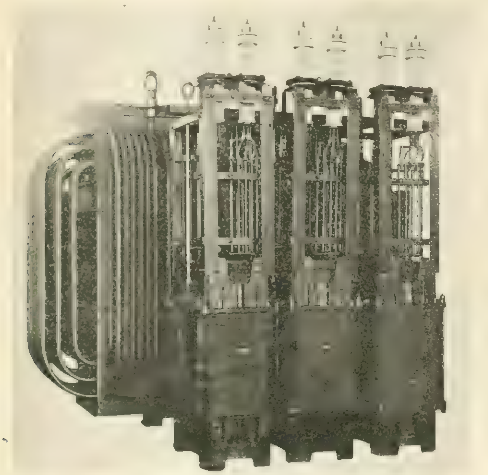


FIG. 1.—THREE-PHASES OF A 2,500-K.V.A. THREE-PHASE, OIL-IMMERSED SELF-COOLED TRANSFORMER, LIFTED OUT OF TANK. 20,000/1,012 VOLTS, 25 CYCLES.

2 500-K.V.A. 3-PHASE OIL-IMMERSED SELF-COOLED TRANSFORMER.

Six 2 500-k.v.a. 3-phase, 25-cycle transformers are being manufactured for the Melbourne Suburban Railways. Each of these 3-phase transformers consists of three separate 833⅓-k.v.a. single-phase shell type transformers placed in one tank. The normal voltage ratio is 20 000/1,012 volts, the three transformers being connected in delta on the high tension side and double star on the low tension side for feeding a 6-phase 2,250 kw. rotary converter. Tappings are provided so that the full secondary pressure is maintained if the primary voltage is 2½, 5, 7½ or 10 per cent. below the normal.

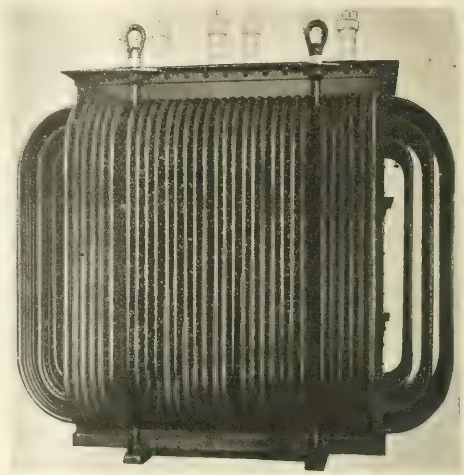
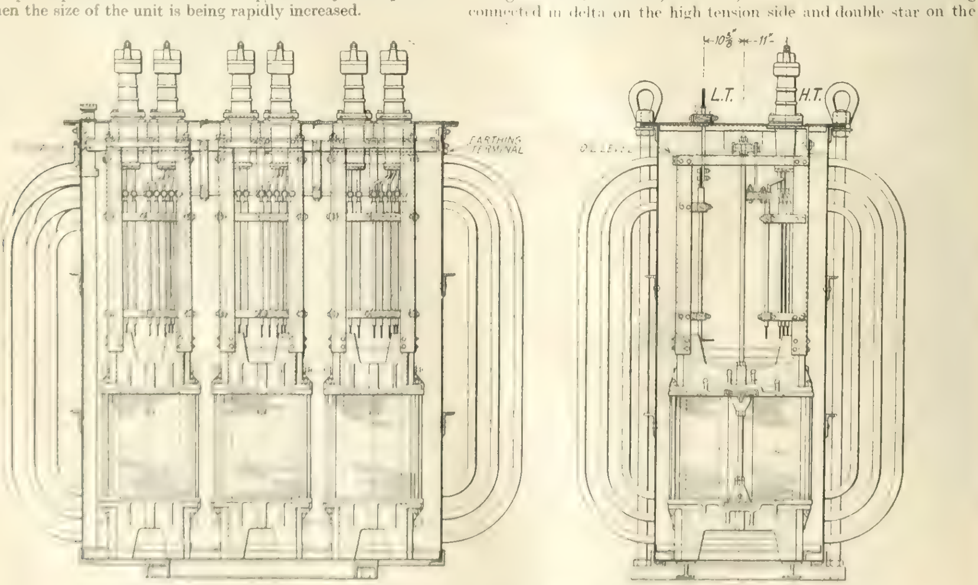


FIG. 2.—2,500-K.V.A. TRANSFORMER IN TANK WITH RADIATING TUBES. 20,000/1,012 VOLTS, 25 CYCLES.



[illegible] TRANSFORMER FOR M[illegible] SUBURBAN RAILWAY.

[illegible]

Both the primary and second ry windings consist of several divisions, each of which is a flat coil, wound radially on a rectangular mould with rounded corners, in a number of layers but with only one turn per layer. The coils are arranged to form groups of the primary and secondary windings, the groups being suitably sandwiched. Between all coils and groups, impregnated insulation is so placed as to allow numerous ducts for the circulation of the oil, while giving rigid support to every turn in the winding so that

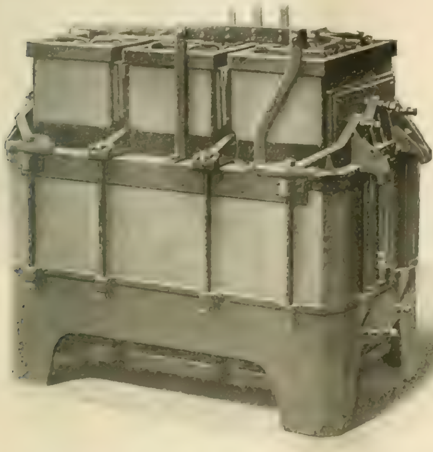
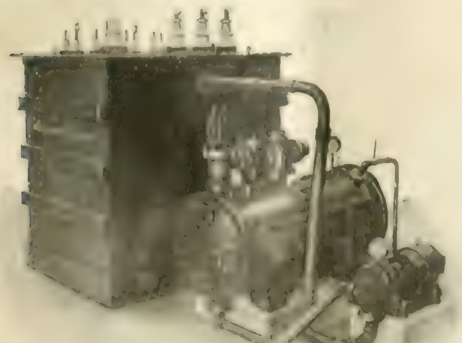


FIG. 1.—ASSEMBLED CORE AND [illegible] CIRCUIT FOR 9,000-K.V.A. THREE-PHASE, OIL-IMMERSED, [illegible]-COOLED AUTO TRANSFORMER. 6,850/2,500 VOLTS, 25 CYCLES.

no individual turn is liable to move. As a result of the high degree of sub-division of the windings the temperature rise at all parts is practically uniform. A number of turns at each end of the high-tension winding of each transformer are insulated to withstand the full line pressure between adjacent turns. The sandwiched high- and low-tension groups in each phase are solidly enclosed in insulation on the four sides leaving the ends open for the circulation of oil through the winding and ducts.



[illegible]

[illegible]

The three units are mounted in a rectangular boiler plate tank having three rows of external oil cooling tubes through which the oil circulates. The transformers are secured in the tank by channel iron work of generous proportions so arranged that any one of the transformers may be removed without interfering with the other two (*see* Fig. 1).

The connections [illegible] from the coils to the [illegible] gear of the transformer and are securely braced to withstand the forces on short circuit. The high tension tappings are carried on the high-tension terminal porcelains so that the high-tension mains

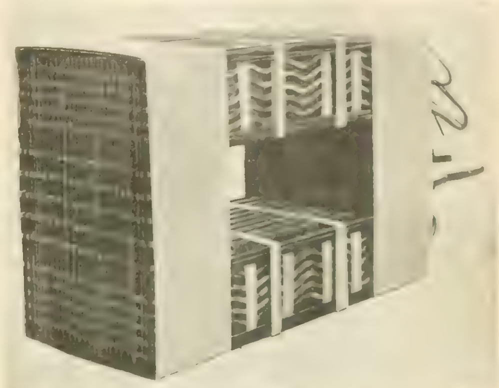


FIG. 6.—ONE PHASE OF [illegible] K.V.A. [illegible] IMMERSED, FORCED-COOLED AUTO TRANSFORMER, [illegible] VOLTS, 25 CYCLES.

can be connected up to the tappings [illegible] without interfering in any way with the transformers or the tank (*see* Fig. 2).

9,000-K.V.A. 3-PHASE OIL-IMMERSED [illegible] AUTO TRANSFORMERS.

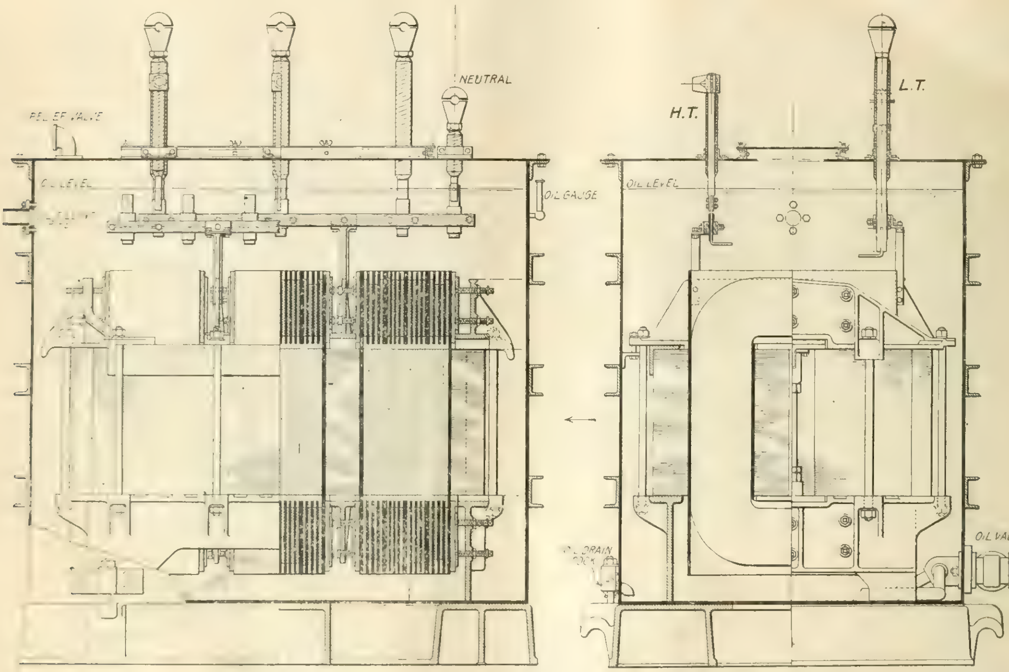
A third transformer for the [illegible] [illegible] transformers at present [illegible]

[illegible]

[illegible]

coil-supports are provided for the three phases, consisting of heavy wooden blocks backed by steel plates which are pressed against the outer insulation of the coils by a nu ber of set screws, clamping

As may be seen from Fig. 5 the complete transformer is contained in a plain rectangular boiler plate tank with channel iron stiffening, the leads passing through the tank cover and being securely braced.

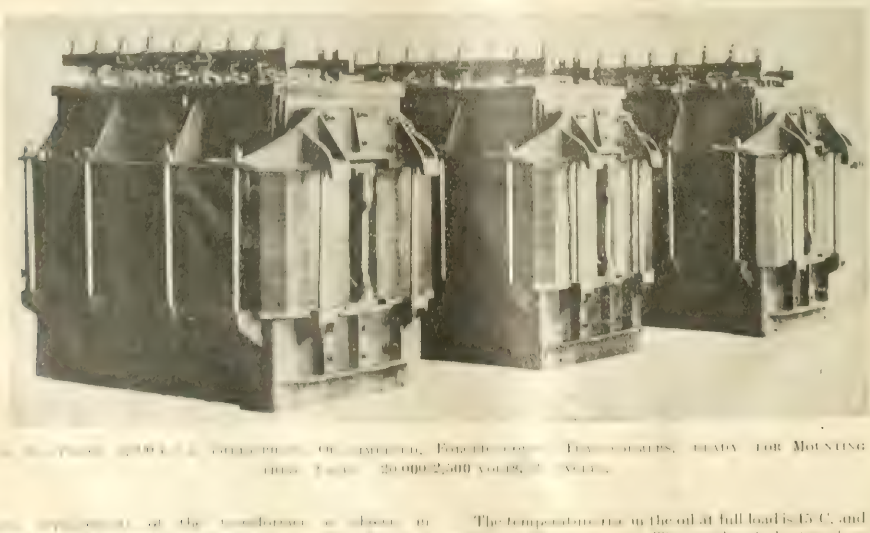


(View looking in direction of Arrow.)

FIG. 7.—GENERAL ARRANGEMENT OF 9,000 K.V.A. AUTO TRANSFORMER FOR L.C.C. TRAMWAYS.

the coil heads securely and preventing any possible movement of the windings. The coils are also provided with special vertical coil supports.

The transformer is oil immersed and the heated oil is pumped through an external oil cooler, where it is cooled by water circulation and returns cold into the transformer.



[illegible] OIL-IMMERSED, FORCED-COOLED TRANSFORMERS, READY FOR MOUNTING IN THEIR TANKS. 20,000/2,500 VOLTS, [illegible]

[illegible] arrangement of the transformer is shown in [illegible] The frame is [illegible]

The temperature rise in the oil at full load is [illegible] C. and the full load efficiency [illegible] per cent. The weight of the transformer complete with oil is [illegible] tons.

3,900-k.v.a. Oil-immersed Forced-cooled Transformer.

Fig. 8 shows three of the four 3,900 k.v.a. 3 phase 25 cycle shell type transformers supplied to the Central Argentine Railways. These transformers are designed for 20,000 volts star/2,500 star,

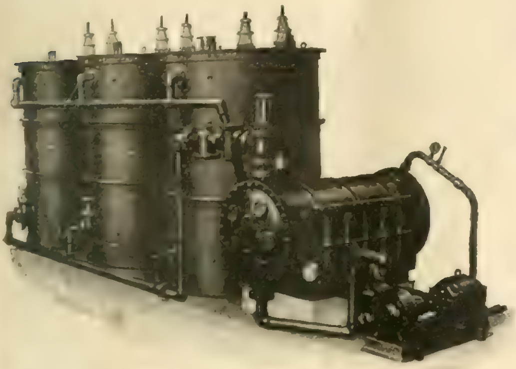


Fig. 10.—13,200-k.v.a. Three-phase Group, Oil-immersed, Forced-cooled Transformer with External Oil Cooler and Motor-driven Oil Pump. 3,300/20,000 volts, 25 cycles.

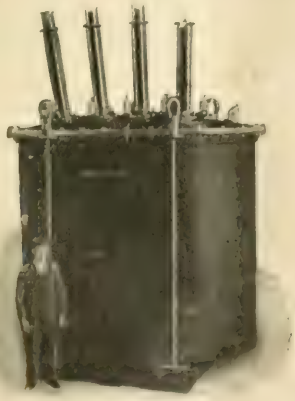


Fig. 11.—[illegible] Oil-immersed, Water-cooled Transformer. [illegible] volts, 25 cycles.

[illegible] continuously at a temperature [illegible]. The general arrangement and construction of these transformers is similar to that described for the 9,000 k.v.a. auto transformers.

transformers [illegible] volts star at 25 cycles. [illegible] forced-cooled type. The complete 3-phase group [illegible] Fig. 10. Th[illegible] group [illegible] measured by [illegible] cent.

The construction is of the standard shell type as detailed above in describing the transformers for Melbourne.

High-voltage [illegible] Transformers.

Figs. 11 and 12 [illegible] Fig. 13 shows the details of [illegible] volts

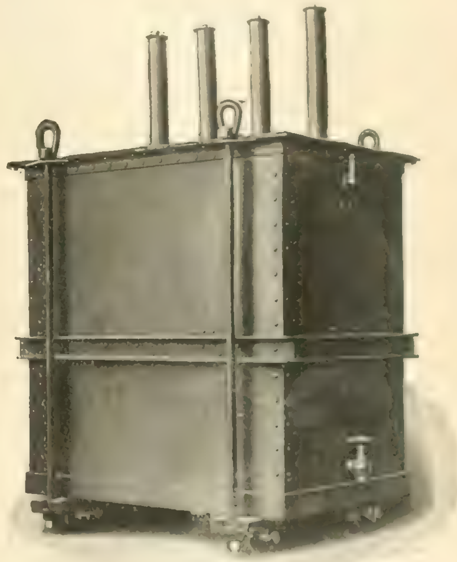


Fig. 12.—[illegible] Transformer. [illegible] 25 cycles.

This [illegible]

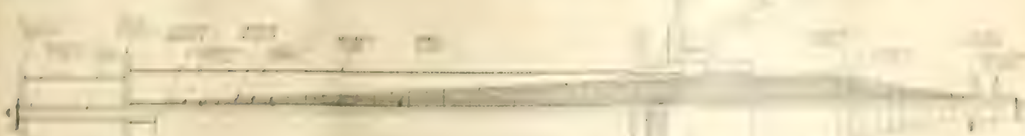


Fig. 13.—[illegible]

[illegible]

In Fig. [illegible] groups recently supplied for the [illegible] State Railways. These [illegible]

APPARATUS FOR MEASURING VERY STRONG OR VERY WEAK ALTERNATING CURRENTS, WITH ADJUSTABLE FIELD MAGNET.

BY SIGNOR PESTARINI.

The arrangement here described comprises a special galvanometer and a static phase transformer fed from an alternating auxiliary source. The galvanometer comprises two coils, one fixed and the other movable.

If the current to be measured is weak, it is passed through the moving coil, and the phase transformer feeds the fixed coil, as indicated in Figs. 1 and 3. If the current to be measured is large, it is sent through the fixed coil and the moving coil is fed by the phase transformer (Figs. 2 and 4). The theory of the apparatus is the same in both these cases, and I shall therefore examine only the case for weak currents.

The moving coil of the galvanometer can be suspended by a torsion wire, or suspended freely, having no torsion couple.

1. The Moving Coil is Suspended by a Torsion Wire.

The fixed coil produces a field H in which the moving coil is placed. I take it for granted that for the moment this sinusoidal field H is in time relation and uniform in the space near the moving coil. I take the phase of this field as the origin of the phases. The torsion couple is zero for the position where the moving coil does not encircle any flux.

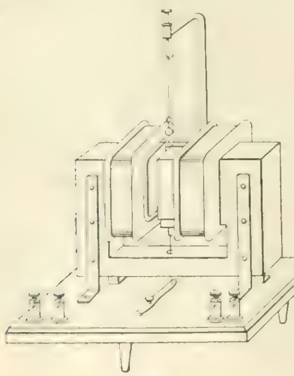


Fig. 1.

I [illegible] that the circuit, into which the moving coil is [illegible] is the only one; the alternating flux interlinked with the moving coil, whose total surface is S, produces an E.M.F. E in the [illegible] given by

$$E = -S\frac{dH}{dt}\sin\alpha \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where α is the angle between the normal to the coil and a plane perpendicular to the field H. This E.M.F. if it existed [illegible] would produce a current

$$I' = \frac{E}{\sqrt{R^2+L^2\omega^2}} \, [\text{illegible}] \, \theta \qquad .$$

[illegible] R, L [illegible] the resistance of the [illegible] the coefficient of self induction and the [illegible] of the [illegible]. Finally θ is such that $\tan\theta = L\omega/R$.

Let I be the [illegible] E.M.F. [illegible] in the circuit of the moving coil, [illegible] of all E.M.F. [illegible] in the [illegible] I [illegible] E.M.F. would produce [illegible]. Finally let φ be the difference of phase between field H and the current I.

[illegible]

[illegible] current I is

$$[\text{illegible}] \, H_{\text{eff.}} \, I_{\text{eff.}} \, [\text{illegible}]$$

Average electromagnetic couple caused by current I' is

$$\frac{S^2H^2_{\text{eff.}}\omega}{\sqrt{R^2+L^2\omega^2}}\sin\alpha\sin\theta.$$

Torsion couple $= -K\alpha$, where K is a constant of the apparatus. Therefore, for equilibrium, we have:

$$-SH_{\text{eff.}}\,I_{\text{eff.}}\cos\varphi - \frac{S^2H^2_{\text{eff.}}\,\omega}{\sqrt{R^2-L^2\omega^2}}\sin\alpha\sin\theta - K\alpha = 0 \quad . \quad (2)$$

Let us suppose α to be very small so that we may substitute

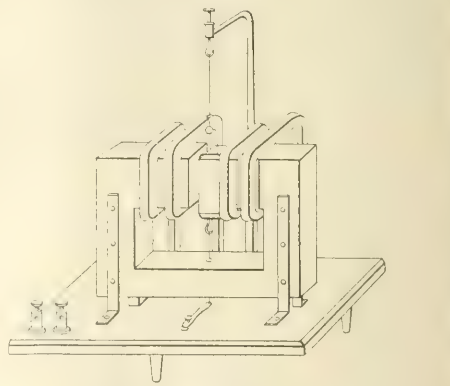


Fig. 2.

the angle for its sine, then we may write the equation (2) in the following form:

$$\alpha\left(K + \frac{S^2H^2_{\text{eff.}}\,\omega}{\sqrt{R^2+L^2\omega^2}}\sin\theta\right) = -SH_{\text{eff.}}\,I_{\text{eff.}}\cos\varphi \quad . \quad . \quad . \quad (3)$$

α becomes a maximum in absolute value for $\varphi = Q\pi$ (Q is a whole number), and becomes zero for $\cos\varphi = (Q+\frac{1}{2})\pi$.

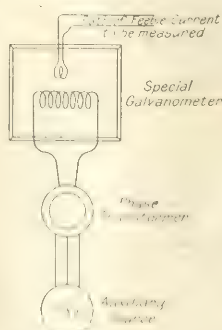


Fig. 3.—Arrangement for Measuring Feeble Currents.

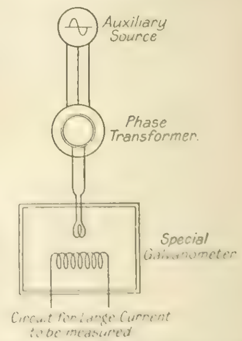


Fig. 4.—Arrangement for Measuring Very Large Currents.

By adjusting the phase transformer, let us cancel φ. We shall then have

$$\alpha\left(K + \frac{S^2H^2_{\text{eff.}}\,\omega}{\sqrt{R^2+L^2\omega^2}}\sin\theta\right) = -SH_{\text{eff.}}\,I_{\text{eff.}} \quad . \quad . \quad (4)$$

Therefore, if we turn the phase transformer slowly, the deviation of the spot will pass through a maximum, and that maximum deviation is in proportion to the current to be measured I.

Equation (4) may be given in a more convenient form, as follows [illegible] a [illegible] deviation to the head to which the

suspension wire is fixed, that is to say α', this deviation being observed with the circuit of the moving coil cut-out. Then close this circuit, but without creating the E.M.F. E, which will give a new position of equilibrium and a new deviation α''; we can then write, always substituting the angle α for its sine,

$$(\alpha''-\alpha')K-\alpha''\frac{S^2H^2_{eff.}\sin\theta\omega}{\sqrt{R^2+L^2\omega^2}}=0,$$

from which

$$\frac{S^2\omega H^2_{eff.}\sin\theta}{\sqrt{R^2+L^2\omega^2}}=K\frac{\alpha'-\alpha''}{\alpha''},$$

and, by substituting in (4), we obtain

$$\alpha K\left(1+\frac{\alpha'-\alpha''}{\alpha''}\right)=SH_{eff.}I_{eff.} \quad . \quad . \quad . \quad . \quad (5)$$

or

$$\alpha\frac{K}{SH_{eff.}}\left(1+\frac{\alpha'-\alpha''}{\alpha''}\right)=I_{eff.}$$

This formula brings into evidence the factor $K/SH_{eff.}$, which is none other than the constant of the apparatus graduated continuously like an ammeter (*see* Note 1).

Let us note that the torsion should be zero exactly for the position of the moving coil for which the encircled flux would be zero. This is obtained by adjusting the head to which the suspension wire is fixed until the deviation which was observed on re-establishing the circuit of the moving coil, after having cut it, is zero. (Field H can also be cancelled and re-established).

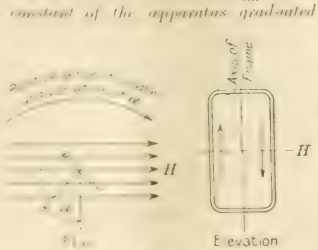


Fig. 5.

2. MOVING COIL SUSPENDED FREELY WITHOUT TORSION COUPLE.

In this case it is the static E.M.F. created by the alternating flux encircled by the moving coil which will produce the equilibrium, as already shown by Mr. Abraham.

The moving coil will be in equilibrium in one position if this induced E.M.F. is such that:

1. The resulting current in the moving coil is zero.
2. Or the resulting current in the moving coil is displaced by 90° in time relation with the field H.
3. Or finally, such that the position of the moving coil reduces the applied couple on the coil to a single force in the plane of the coil and of its axis.

In order to prevent the circuit of the moving coil encircling a flux created by the alternating field [illegible] that one embraced by the moving coil, the current should not be conducted by the suspension [illegible] but either by two fine flexible wires twisted together, suspended freely and free from any supplementary couple, or else an arrangement could be made with two fine, rigid, parallel wires close to each other, supported, for example, by a light sheet of mica and immersed in two small cups of mercury.

Let us construct the diagram in time relation to the position of equilibrium (see Fig. 6). Let the phase of the field be the origin of the phases. Let od be the E.M.F. $E_{eff.}$ to be measured, od will be the current $I_{eff.}$ which this E.M.F. would create if it were alone. These two vectors are out of phase by an angle θ such that $\tan\theta=L\omega/R$, where L and R are the coefficient of self-induction and the resistance of the circuit of which the moving coil is a part.

In the diagram [illegible] has been taken positive, then α will be [illegible] and $E_{eff.}=SH_{eff.}\omega\sin\alpha$ will be included in oh; the current $I_{eff.}$ due exclusively to this E.M.F. E, will be taken on of displaced from oh by the angle θ. The segment of, representing $I_{eff.}$, should be taken so that the resulting current og, which it gives with od, be in the direction ob, at 90° to the field.

Let us then construct on of as side, a triangle ofe, similar to ocd: oe will be $E'_{eff.}$, and if we describe a circle with a radius equal to $SH_{eff.}$, the angle included between oa and oh will be the angular deviation of the coil for the position of equilibrium. The angle α is to be taken clockwise.

For each value of the angle φ there corresponds one value and one only of the angle α; the absolute value of the angle becomes a maximum when $\varphi=Q\pi$, where Q is a whole number, and the deviation will be zero for $\varphi=(Q+\frac{1}{2})\pi$. (*See* Note 2.)

In the case of $\varphi=0$ the diagram becomes that of Fig. 7, and we may write:

$$\left.\begin{aligned} I'_{eff.}&=\frac{E'_{eff.}}{R}\cos\theta \\ I_{eff.}&=\frac{E_{eff.}}{R}\cos\theta \\ E'_{eff.}&=S\omega H_{eff.}\sin\alpha \\ I_{eff.}&=I'_{eff.}\sin\theta \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

from which may be deduced—

$$E_{eff.}=SH_{eff.}\omega\sin\theta\sin\alpha.$$

and

$$I_{eff.}=SH_{eff.}\omega\frac{L\omega}{R^2+L^2\omega^2}\sin\alpha,$$

and if α is small enough for the angle to be substituted for its sine, we have

$$\left.\begin{aligned} E_{eff.}&=SH_{eff.}\omega\frac{L\omega}{\sqrt{R^2+L^2\omega^2}}\alpha \\ I_{eff.}&=SH_{eff.}\omega\frac{L\omega}{R^2+L^2\omega^2}\alpha \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

wherefore $E_{eff.}$ and $I_{eff.}$ are here still proportional to the angle of deviation α.

We find here again the same properties as for the coil suspended to a torsion wire, viz.:—

If the phase transformer is turned slowly, the deflection of the coil reaches a maximum value for a certain position in which the current I, which the exterior E.M.F. would produce

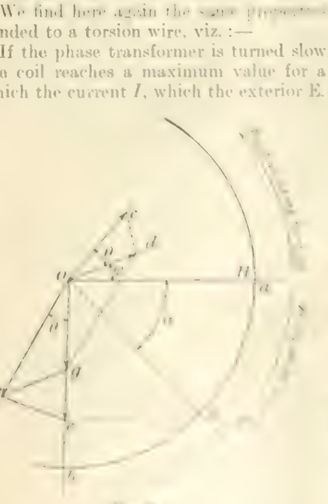


Fig. 6.


Fig. 7.

if it acted alone, is in phase with or in opposition to the field H, and this deflection is in proportion to the current and to the E.M.F. $E_{eff.}$, depending on the constants of the apparatus and of the circuits.

In order to determine the constants of apparatus, we can proceed as follows:—

A. The flux $SH_{eff.}$ is a constant of the apparatus [illegible] and will be determined once for [illegible] will become [illegible] proportional to the voltage at the terminals [illegible] on the other hand, H and L [illegible] circuit. H can be [illegible] [illegible]

eliminated by making a new measurement with a known auxiliary self-induction, introduced into the circuit, or with one and then two unknown but identical self-inductions. (See Note 3.)

Thus, the apparatus can be calibrated in the same way as a voltmeter or an ammeter.

B. In the case of the voltmeter, in any case, one could graduate more rapidly by introducing into the circuit of the moving coil a known E.M.F. by means of a mutual induction known or easily calculable. In this way the constant

$$S\omega H_{\text{eff.}}\frac{L\omega}{\sqrt{R^2+L^2\omega^2}}$$

can be determined by a single supplementary measurement. (See Note 4.)

The zero of the scale can be determined by taking the point where the spot of light comes to rest when the exterior E.M.F. is cut out, without, however, breaking the circuit of the moving coil. (See Note 5.)

USE OF THE APPARATUS AS A PHASE METER.

Let us abandon now the distinction between the moving coil suspended by a torsion wire and that which is not so suspended.

The preceding formulæ show an absolute maximum deflection when the angle φ between the current to be measured I and field H is $Q\pi$ (where Q is a whole number) and a deflection of zero for $\varphi=(Q=\frac{1}{2})\pi$. The relative position of the two windings of the phase transformers feeding the fixed circuit of the apparatus in question can, therefore, serve as an indicator for the phase of the current to be measured.

If two currents are thus indicated, the difference of phase between them will be known.

It is evident that the phase indication is much more exact for the zero deflection, when the current I and the field H are at 90 deg. than for the maximum deflection.

USE OF THE APPARATUS AS A FREQUENCY METER.

Let us pass the current to be studied through the moving coil, for example, and feed the fixed circuit from an auxiliary source having a known variable frequency at each instant.

Let us vary the frequency of this source in a uniform manner. The spot which, at the beginning, oscillates, generally very sharply with a very slight displacement, will oscillate with less and less frequency and with increasing amplitude until it finally assumes a fixed deviation.

Then the current to be studied will have the same frequency as the field, that is to say, as the auxiliary source, which latter is known.

USE OF THE APPARATUS FOR THE DETERMINATION OF THE HARMONICS OF A PERIODIC CURRENT.

Let

$$I=I_1\sin(\omega t-\varphi_1)+I_2\sin(2\omega t-\varphi_2)+I_3\sin(3\omega t-\varphi_3)+\ldots,$$

and the induction in the air gap of the apparatus in question, $B=B_m\sin m\omega t$, where m is a whole.

Let us suppose the series $I_1+I_2+I_3\ldots$ absolutely convergent. Let $T=2\pi/\omega$ and C the mean electromagnetic couple. If K is the constant of the apparatus we shall have

$$C=\frac{K}{T}\int^{T}I_1B_m\sin(\omega t-\varphi_1)\sin m\omega t\,dt+$$

$$\frac{K}{T}\int I_2B_m\sin(2\omega t-\varphi_2)\sin m\omega t\,dt+\ldots$$

$$\frac{K}{T}\int^{T}I_mB_m\sin(m\omega t-\varphi_m)\sin m\omega t\,dt+\ldots$$

$$=\tfrac{1}{2}KI_mB_m\cos\varphi_m \quad \ldots\ldots\ldots \quad (9)$$

and if, by shifting the phase transformer, one makes $\varphi_m=0$, we have a maximum couple

$$C=\tfrac{1}{2}KI_mB_m \quad \ldots\ldots\ldots \quad (10)$$

from which one deduces I_m.

By modifying successively the frequency of the auxiliary source and, with the phase transformer and a key, latter in [illegible], feeding the fixed circuit of the apparatus in question, one might thus obtain all the desired values and determine the successive $I_1, I_2, \ldots$ [illegible]

An ordinary wattmeter, such as one has always on hand, could be employed according to the principle shown.

It is thus that with a wattmeter, of which the thick wire was fed by an auxiliary current at a convenient displacement, I have applied the method of opposition to the determination of the ratio of the transformation of transformers by bringing back the measure of this ratio to that of two resistances of the kind used in resistance boxes. The approximation so obtained was to one part in a thousand.

It is also with this apparatus that I have attempted to study the currents due to the conductance of the insulation, to the capacity, &c., in transformers.

NOTES.

1. The constancy of H during a measurement can easily be controlled, because one can also calculate the fixed coils so that the voltage at their terminals may be sufficient.

It is also noticeable that a slight error in the determination of the position of the phase transformer, for which $\varphi=Q\pi$, gives a very slight error on a, as this latter is then at its maximum.

2. In fact, if we consider a triangle, one angle of which is constant, and the side opposite to this angle is of constant length, one of the two other sides becomes a maximum when the side of constant length becomes perpendicular to the third side. Thus, in diagram 6 the triangle of g has its angle θ constant, and its side fg is opposite to this constant angle, so that of becomes a maximum when fg is perpendicular to og, that is to say, when od is parallel to oa. With of, oe becomes a maximum also, as the triangle of e is always similar to itself and with oe the absolute value ofa also becomes a maximum.

3. Wherefore, we have

$$E_{\text{eff}}=S\omega H_{\text{eff}}\frac{L\omega}{\sqrt{L^2\omega^2+R^2}}a,$$

viz., L_e the value of each of the two auxiliary self-inductions, but unknown:

$$E_{\text{eff}}=S\omega H_{\text{eff.}}\frac{(L+L_e)\omega}{\sqrt{R^2+(L+L_e)^2\omega^2}}a',$$

$$E_{\text{eff.}}=S\omega H_{\text{eff.}}\frac{(L+2L_e)\omega}{\sqrt{R^2+(L+2L_e)^2\omega^2}}a'',$$

from which we derive L.

4. For example, a ring having 1,000 primary turns fed from an auxiliary source and one secondary turn, this turn would form a permanent

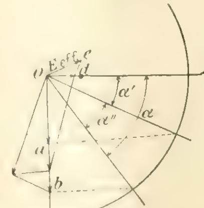


FIG. 8.

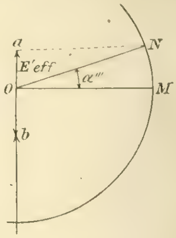


FIG. 9.

part of the circuit of the moving coil, in order not to modify the total inductance of the circuit. From the voltage at the terminals of the primary, a voltage which can be made sufficiently high and can be therefore controlled with precision, the phase induced from the single secondary coil can be deduced.

5. By operating in this manner one eliminates the error caused by the E.M.F. due to a flux created by the apparatus, but not to a flux embraced by the moving coil by a bad arrangement of the connections.

In fact, the disturbing E.M.F. joins in with the E' caused by the flux of the coil, and while E'_{eff} is a function of the position of the coil, the disturbing E.M.F. is independent of it. In Fig. 8 I have taken account of this disturbing E.M.F. in ab in the same sense as the $E'_{\text{eff.}}$. Thus, the coil deviates from the angle a, instead of deviating from the angle a, which would be correct, we have

$$a=a+a';$$

and if a' is very small

$$\sin a'=\frac{ab}{oM}.$$

Let us construct further on (see Fig. 9) the diagram for the case, where $I=O$. Then the coil will take up a new position different from that for which it embraces no flux, as follows:—

$$\sin a'''=\frac{ab}{oM}=\frac{oa}{oM}.$$

This means that [illegible]

If, therefore, we substitute the angles for their sines in view of their small dimensions, and if we take as origin for measurements the position ON instead of OM, we shall eliminate the error caused by the disturbing E.M.F.

The diagrams give a general idea of the apparatus, a more suitable form of which will be constructed in London by Mr. R. W. Paul.

THE DOVER TRAMWAY ACCIDENT.

Col. J. W. Pringle has issued his report on the accident which occurred to a tramcar on the Dover & River Light Railway on Aug. 19 last.

The car (No. 20) got out of control as it was descending Crabble Hill. The speed rapidly increased and the car left the rails on a curve at the foot of the hill. In crossing the road to the right it overturned; and, in falling, struck the front wall of Crabble Paper Mills premises. The conductress and 10 passengers were either killed or died subsequently from injury; and all the remaining passengers (59) suffered more or less seriously from injury or shock. The driver, A. J. Bissenden, jumped from the platform half-way down the hill and escaped unhurt. The gauge of the Dover Corporation Tramways, of which the route is a section, is 3 ft. 6 in. The car was a double-deck, single-truck car, and it contained seating accommodation for 22 inside and 26 outside passengers. It was equipped with (*a*) hand brake working c.-i. blocks on all four wheels by means of a handle, vertical spindle and chain; (*b*) electric rheostat brake; and (*c*) track brake, consisting of two oak-shod shoes, one between each pair of wheels, actuated by hand wheel from each platform. After describing the route, the gradient curves, &c., it is stated that the route was inspected in September, 1905, and opened to traffic shortly afterwards. There has been no previous case of a car getting out of control.

Driver A. J. Bissenden was formerly in the Army (Army Ordnance Department). He returned to England in February, 1917, after 15 months' service in Egypt, suffering from nervous breakdown due to heat and overwork. He was discharged from the Army as unfit for further military service on June 1, 1917. He applied for employment on the Dover Tramways on July 21, 1917. The manager (Mr. Carden) judged he was likely to prove suitable for the position of motorman, and put him in for instruction under Driver Brett, who had over 10 years' service. He was under tuition for nine days, and he was finally put on the list as regular motorman on Aug. 1. Between Aug. 1 and 15 inclusive he drove a car daily on the level portion of the tramway system between Buckland and the Pier. Prior to the accident he had driven down Crabble Hill on service on 8 or 10 occasions. On Aug. 19 he came on duty at 10.40 a.m. and drove on the Buckland-Pier route until 1.38 p.m. After dinner he relieved another driver on car No. 20 to work the River route service. Before reaching Buckland the conductress (Lottie Scrase) told him that the car was full, so as to avoid stopping at traffic points to pick up other passengers. Bissenden stopped the car at the foot of the hill near the Buckland tramway shed by using the hand brake, which was then working efficiently. He then proceeded up the incline in London-road, and, passing the summit, threw over his controller and tried to stop the car at the compulsory stopping-place with the hand brake. He found the brake would not stop the car; he then tried to screw down the slipper brake, but the car was making speed so rapidly that the blocks would not hold. He then tried to apply the rheostatic brake, but could not get the small reversing handle to move into the right position. As he could do nothing more, he jumped off the front platform before the car reached the railway arch. Other witnesses relate that a soldier (Trooper Gunner) and a gentleman (Naval Pensioner Miller) went on the front platform after the driver had jumped off it. It is not clear whether these men attempted to work the brakes or not. In any case, no retardation of speed was effected. Passing under the railway arch, the trolley pole left the conductor wire and swung loose. The conductress was on the top deck during the rush of the car down hill, and no one was observed to attempt to apply the hand or slipper brake from the rear platform. About 110 ft. below the railway arch the car entered the second curve and left the rails. The wheel marks cross the road diagonally to the right for a distance of about 30 ft. and then disappear. It is evident that on this short distance the car was overturning to the right, with the left hand wheels in the air. When the car came to rest it lay on its right side at right angles to and across the roadway.

Col. Pringle states: "I examined the condition of the car after it had been moved to one side of the roadway. [illegible] result of the accident, but could still be operated by the hand wheel at each end of the car. [illegible]

possible for the chain to become unhooked, whilst the car was travelling a distance of about 700 yards from the tramway shed to the top of Crabble Hill. Possibly, after Bissenden jumped off the car, either Trooper Gunner or Mr. Miller, if they worked the hand brake handle, turned it in the wrong direction and thereby caused the chain to slacken considerable off the spindle and hand loose. The evidence given by Driver Cook and Mechanic Knott, who were the first to observe the position of and remove the controller handles, is to the effect that the small handle was in the "ahead" and the large in the "last power" (full parallel) position. I agree with these witnesses that no jolting or jarring during the overturning of the car is likely to have thrown both the handles into these positions, and they bear no marks of having been struck by any object. Bissenden's own statement that he was unable to move the controller (small) handle into the emergency brake position confirms, in my opinion, the view that power was applied as the car came down the hill. The interlocking of the two handles makes it impossible to move the small handle unless the large (power) handle is in the "off" position. I proved for myself after the accident that there was no difficulty in moving the controller handle from "ahead" to "astern" or "emergency" with the power handle in the "off" position. I come, therefore, to the conclusion that this lamentable accident was caused by driver Bissenden failing to cut off power as he approached the compulsory stopping-place on the summit of Crabble Hill, and by his further failure to utilise properly the sand and brake equipment. Power was not, I think, cut off until the trolley left the conductor at the railway bridge, when the speed attained by the car probably already exceeded 20 miles per hour. It is evident that Bissenden completely lost his head at the critical moment."

Col. Pringle draws attention to three important points in connection with this accident:—

(1) Nerve and experience are necessary qualifications for tramway drivers, especially when traffic has to be conducted over severe gradients and in crowded centres. Men discharged as unfit for military duties on account of nervous breakdown are unlikely to prove suitable, two months later, as drivers on difficult routes. At all events, medical opinion should be sought before a candidate of this description is accepted. I doubt whether Local or County Appeal Tribunals are aware of the difficulties which tramway managers nowadays encounter in finding suitable substitutes to fill the places of experienced drivers taken for military serivce. At the outbreak of war 24 men were employed on the Dover tramways. Of these [illegible] four had less than 1 year's service. None of them were under 23 years of age. At the present moment the staff has been reduced to 18. Of these, five only have 5 or more years' service, nine have less than 2 months, two less than 4 months, one less than 8 months, and one under 15 months' service. Six of those now employed are under 18 years of age. During the war 22 drivers have enlisted, or been claimed for military service, and 19 have left for better-paid employment. Col. Pringle says: "I do not think that the accident would have occurred had it been possible to maintain a staff of experienced drivers, such as was in existence in August, 1914.

(2) A longer training [illegible] brake) and experience than that possessed by driver Bissenden are necessary to qualify a driver to work traffic on such a section as the River route.

(3) Overcrowding, when a car [illegible] causes a serious list of casualties. [illegible] accident of this sort is likely to be comparatively small. The liability to overturn on the narrow [illegible] on the ordinary gauge. The determining factors in overturning, outside [illegible]

BOOKS RECEIVED.

[illegible]

The Electrician.

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CO-OPERATIVE EDUCATION.

Last Thursday a remarkably unanimous and very representative meeting of engineers and educationalists was held, at which a scheme was launched for a genuine co-operative effort in technical education, a central organisation being the means to this end.

Many people have asked themselves from time to time what is wrong with our technical education. The situation has been somewhat perplexing because educationalists have frequently taken one point of view and manufacturers another. It is an old saying that the onlooker sees most of the game. We do not profess to be educationalists, nor are we manufacturers; but we have had the advantage of looking on at the game, and it has often been clear to us that, while educationalists wrangled, the manufacturers held aloof. This was an unfortunate state of affairs, which could be productive of no good, and we therefore welcome the present movement if only for the fact that it is bringing educationalists and manufacturers together, so that there will be co-operative effort, instead of either side belittling the efforts of the other. It can only be a qualified success if the educationalist turns out a product without knowing what the user of the product desires, and it is equally hopeless for the user to expect the educationalist to turn out the desired product unless he states what he wants.

We think there is no question that our higher technical education may be said to be good at the present time. Generally speaking it provides a sound foundation, and this is of the greatest importance, for unless the foundation is sound any superstructure will only be feeble; whereas if the foundation is satisfactory the young engineer is not limited in any further progress he may wish to make. The chief doubt in the minds of critics in the past has been whether the final product is at present the best that can be produced for the manufacturers' use. The present movement should terminate this difficulty, for, in the words of one of the speakers in the discussion, it is equivalent to the manufacturers admitting their liability to share some of the burden of the educational programme.

Admitting, however, that there is not anything very wrong with our higher technical training, it must be allowed that the position is very far from satisfactory when we look at the training of the rank and file of those engaged in our engineering industries. Little or no attempt has been made to train the apprentice and other youthful workers to any appreciable extent. As often as not he is thrown into the works at the early age of 14, when his work can be of very little value, and when there is no inducement for him to retain the elementary general knowledge which he has already been taught. The future of our industries, and probably their freedom from labour troubles, must depend a good deal upon the education of these boys as citizens and as engineers. The proposals which were recently before Parliament indicate the opening of a new era in education generally, and it will be for the manufacturers of this country to see that the most of this new movement is made for the benefit of engineering.

Let us revert once again to the question of higher technical education. Prof. [illegible] mentioned how before the war he came to the conclusion that there were about 10,000 students in Germany fully educated, compared with which we could only muster in this country about 900. If this is merely a question of standard, the comparison must be deplored. If, on the other hand, it is largely a question of number, we may pause to inquire whether there is room for anything like the larger number indicated. As in other matters, the law of supply and demand must hold; and, as far as we can judge, the supply so far has exceeded the demand, if the salaries paid can be taken as any indication of the supply that is required. Employers must not expect the best brains of this country if they are only prepared to pay paltry salaries. We fear there is a good deal of underpayment of technical men at the present time. One of the speakers in the discussion referred to the inadequacy of paying 5s. a week to an apprentice. This sum is certainly small, but we must remember that an apprentice is being taught; he is young, being usually dependent upon his parents; and, lastly, the position is temporary. The position of the trained technical man, on the other hand, is permanent; and for a salary to be permanently inadequate leads to poor work and to the attraction of poor brains.

In conclusion, let us say that we have every sympathy with the Committee which was formed last week to deal with the whole educational question. It appears to us to be a practical step, and we think that the promoters have done wisely in keeping clear of the Board of Education. By all means keep in close touch with the Board; but if the Committee is to do active work, let it not be dependent upon a Government Department whose mode of thought has long since been crystallised. There is much work to be done before the technical education as a whole will be such as befits the position of this country. Moreover, we have a duty to the rising generation in all sections of the community, and no suitable programme will be evolved without a realisation of this fact on the part of the manufacturer. The active participation of manufacturers in educational questions has been desirable for many years, and it appears to us that the formation of the present Committee will bring about this very needful change.

REVIEW.

General Cargo: An Introduction to Salesmanship. By R. E. GODDARD. (London: Constable & Co.) Pp. viii. + 199. 4s. 6d. net.

This book is a purely commercial volume, the contents of which are not obvious from the main title. It is concerned with salesmanship. At the present time such a subject is of great importance, not so much on account of immediate requirements, but of future developments.

The author deals in a chatty fashion with the general subject of salesmanship in its broader aspects, starting with the factory and passing on to the requirements of specific parts of the world from the point of view of developing foreign trade. The advantages of colonial markets are discussed, but it is pointed out that they are easy markets, and as such they may lead to slackness on the part of the exporter, which unfits him for meeting foreign competition in other parts. This neglect of the foreign market has been thus encouraged.

The author also draws attention to the desirability of sometimes manufacturing the cheaper as well as the more expensive lines of goods. To this course the British manufacturer generally seems averse, but it is well to draw a distinction between the "cheap and nasty" and that which is cheap and yet is not nasty. It is the latter type to which more attention should be given.

We think many of our salesmen will do well to read the common-sense remarks of Mr. Goddard.

ENGINEERING TRAINING.

A meeting was held at the Institution of Civil Engineers, Westminster, on Thursday, October 25th, for the purpose of considering the establishment of a central organisation for improvement in and better co-ordination of engineering training, and the appointment of a representative committee of engineering and educational interests to initiate action.

Sir Maurice Fitzmaurice, C.M.G., President of the Institution of Civil Engineers occupied the chair.

The invitation to the meeting stated that neither the Institution of Civil Engineers nor any other institution is as yet officially committed to support any specific scheme, and that the immediate object of those responsible for arranging this meeting was to bring together the various representative interests in the furtherance of an object that is common to all.

Amongst the delegates appointed to attend the meeting were representatives of the Reconstruction Committee, the Admiralty, India Office, Board of Education, and other Government Departments, the engineering, scientific and industrial institutions, including the Federation of British Industries, and the universities and technical colleges.

Mr. Herbert Fisher, President of the Board of Education, had intended to be present and to speak at the meeting, but other duties intervened, and he sent a letter which was read at the meeting expressing his approval of its objects.

The following memorandum was distributed amongst the delegates :—

1. The proposal to form a central organisation for improvement in and better co-ordination of engineering training originated in an informal conference of engineers and educationalists, which held several meetings at the Board of Education during the early months of 1917. The object of this conference was to consider certain problems of engineering training more particularly from the industrial point of view, but it soon became apparent that the amount of useful work to be accomplished was altogether beyond the scope of a temporary conference, although well within the power of some permanent organisation.

2. In ceasing its work, therefore, the informal conference presented to the Board of Education a memorandum embodying the suggestion that a bureau might be established within the Department. At the wish of the Board, the suggestion was communicated to as wide a circle of engineers and educationists as possible, and elicited strong support. A marked feature of this support, however, was an expression of opinion on the part of many engineers that it would be preferable to establish the proposed organisation on an independent footing, so that while co-operating closely with the Board of Education and other educational bodies, it might be free from the need of Government finance. Mr. Fisher, President of the Board of Education, concurred warmly with this view, and his department has taken a very close interest in the initial steps of its development.

3. On the evidence of this nucleus of opinion, those more immediately concerned requested the Council of the Institution of Civil Engineers to lend their theatre for a meeting, at which the real need for such an organisation might be confirmed and some definite proposal formulated after discussion of the subject by the principal engineering and educational interests invited to attend. Inasmuch as the broad purpose of the proposed organisation is to provide the engineering industry and profession with a representative brain and articulate voice on educational matters, it is obvious that any such scheme essentially depends on the combined assistance of the various institutions, not only in creating and in helping financially to maintain the organisation, but in enabling it to perform its functions efficiently through the principle of devolution. Primarily it will co-ordinate things that exist, for although it must exert a live and progressive influence, it is in no sense intended to be competitive with institutions that have already done and are still doing most useful work in their individual spheres. Rather will it endeavour to bring them together in conference so as to avoid overlapping of effort, and to take steps that will ensure a more widespread knowledge of and interest in such admirable memoranda as those, for example, issued by the Institution of Civil Engineers and the North-east Coast Institution of Engineers and Shipbuilders.

4. There are three objects in particular on which the proposed central organisation might usefully concentrate its attention. The first is the co-ordination of engineering training [illegible]

[illegible] co-ordination refers primarily [illegible]

[illegible] indeed to overlook the citizen and the man in trying to make the mechanic or to forget the importance of good health and the value of a mind with many interests.

6. Incidentally, there is a widely recognised need for encouraging lads to become apprentices as distinct from mere members of the vast community of child labour, and this recognition extends also to the need for effecting improvement in the educational value of the works period of engineering training, whether it be for the apprentice who seeks to learn a man's skilled trade or for the pupil who is qualifying for ultimate positions of management. Admirable as are the efforts made in some works to afford really effective facilities for a thorough engineering training to those young persons who are capable of profiting by it, in many other directions little or no interest is taken in the development of this potential industrial man-power. What with the inconvenience of instituting educational methods in industrial establishments, and the narrow-minded objection that the fruits of such labours are often apparently plucked by others, much of the field of engineering industry has remained untilled in the educational sense, and equally in industry as in agriculture such a state is alike unprofitable to the individual and to the nation. The significance of the works period in an engineering training cannot be too strongly emphasised, for not only are the shops the natural nursery of the majority of the charge hands, foremen and superintendents, on whose efficacy and efficiency so much of our engineering economy depends, but there is an immensely important section of higher engineering education for which the productive works, or the equivalent civil engineering enterprise, is an indispensable class-room.

7. And in this respect it is important to make clear from the first that the scope of the proposed central organisation, as it has appeared in the minds of those who have been more prominently associated with this movement, has not been restricted to the field of engineering science. The work of the technologist is the foundation on which the engineering industry, in the broader sense of the term, develops, but the problems of economic production, as they appear to the works manager, and, in the higher aspects of business, to the director of engineering commerce, must equally receive attention, if any organised scheme for improvement in and better co-ordination of higher engineering training is to have the success that it deserves.

8. That the time is ripe to bring into existence a central organisation to which engineering firms and others could apply for information relating to apprenticeship systems and methods of training that are actually in operation, may be judged from the number of letters in support that have been received from various sources, and as to any further need for an information bureau (the maintenance of which is the second of the specified objects of the organisation), the answering of the daily letter from the perplexed parent whose son is approaching the completion of his last term at school, may in itself seem to be sufficient justification to the many engineers who would be relieved thereby from the onus of replying to this mass of correspondence. To advise the parent sympathetically and well is a work of first-class importance, because it is of real consequence that every boy should be helped to [illegible] service of which he is capable. As a link by which parents, schools, and universities are enabled to get into direct touch with the engineering industry and profession, the proposed central organisation will be performing one of its most important roles. The letters of support that have been received from the head masters of practically all our public schools are in themselves sufficient evidence of the useful service that such a scheme could render in this direction, and, considering the importance of engineering to the nation, the value of attracting into this field a proper proportion of the [illegible] estimated.

9. And the need [illegible]

The fo[illegible]

initiate means that will give effect to this principle of a central organisation, and that the first members shall be representative of the following bodies: Institution of Civil Engineers, Institution of Electrical Engineers, Institution of Mechanical Engineers, Institution of Naval Architects, Iron and Steel Institute, Liverpool Engineering Society, South Wales Institute of Engineers, Institution of Civil Engineers of Ireland, Institute of Metals, Institution of Municipal and County Engineers, Institution of Gas Engineers, Institution of Mining Engineers, Institution of Mining and Metallurgy, Technical Committee of the Motor Industry, Federation of British Industries, British Engineers' Association, Board of Education, Headmasters' Conference, Incorporated Association of Headmasters, Association of Technical Institutes, Junior Institution of Engineers, North-East Coast Institution of Engineers and Shipbuilders, Institution of Engineers and Shipbuilders in Scotland, British Electrical and Allied Manufacturers' Association, the Universities and technical colleges of university rank, and the Joint Committee of the Aeronautical Society and Society of British Aircraft Constructors."

The CHAIRMAN said he was proud of the fact that he had been asked to preside over what he considered one of the most important meetings ever held there. There were present educationalists, professional and manufacturing engineers and many of the great captains of industry, and if they could agree at that meeting that the subject was of such great importance that they could appoint a committee of those who had had to deal with all the different stages of engineering training, education and apprenticeship, and if that committee could agree on the best means for improvement a great step would have been taken. There was a great gap not fully dealt with at present between the time when a boy arranged that he was going to be an engineer and the time when he actually became an engineer. They lost many engineers on account of that gap, and many of those who became engineers would have been better engineers if they had had some more guide than they had at present. There was no proposal to try and interfere with the programme or activities of any university, engineering institution or society. He would be sorry if any organisation had not enough elasticity in itself to alter its rules if it were proved that such change was required in the best interests of the nation. He put before the meeting four elementary proposals, leaving out the question of finance. The first was that manufacturing and trade interests, in which this country was largely concerned, depended to a large extent upon engineers, acting in many cases with chemists, metallurgists and other profesional gentlemen; the second was that a full supply of young engineers was necessary to recruit the ranks; the third, that it was necessary that such young engineers should have the training necessary for them to prosper in their profession and be the means of causing the industry of the country to prosper; the fourth, that the means for obtaining the necessary training for young men to become engineers were not as satisfactory as they might be at the present time. He hoped the result of that meeting would be a great improvement in the education and training of engineers and the drawing together of the educational, professional and manufacturing interests. The war had drawn them together. Let them form bonds to keep them together in the future when they would have to continue the fight for the commercial [illegible] country.

Mr. A. E. BERRIMAN (Daimler Co.), in giving an outline of the origin and purpose of the proposals to be discussed, said the seed of that meeting [illegible] have been sown by a recommendation made to the B[illegible] by a conference of engineers and educationalists, who having discussed some of the problems of engineering training, more particularly from the industrial point of view, came to the conclusion that [illegible] of useful work that could only be accomplished by some permanent organisation properly authorised to undertake it. The educational needs of the engineering industry justified the creation of some central and representative organisation to deal with such matters.

Mr. [illegible] from the above memorandum, and [illegible] the need for maintaining a central information bureau was also in part related to the problems that arose in [illegible] It was of first class [illegible] should be helped to attain the highest level [illegible] and it was important that he should [illegible] of his career. The third object of the [illegible] of scholarships in favour of [illegible] as widely or as quickly [illegible] at the right time [illegible] had already entered industry, and [illegible] placed them within reach of [illegible] school. The [illegible] organisation [illegible] It must [illegible] scheme of work [illegible] the engineering industry [illegible] matter [illegible] co-operate [illegible] representative and co-ordinate their [illegible] and not be content with the [illegible] At the Board of Education [illegible] within that department, but [illegible] that it would be preferable to [illegible] so that while co-operating [illegible] Mr. Fisher agreed with that view. [illegible] Mechanical Engineers [illegible] he [illegible] of instituting a [illegible] difficulty [illegible] [illegible] could not [illegible] that many proportion of engineering [illegible] works for a short time, and

then go away taking, as they thought, their secrets into other works. Many enlightened engineers had got over that feeling, and the whole nation should get rid of it and consider the interests of the nation and not merely the interests of individual firms. In some cases to get rid of that purpose of limiting the works staff to those intending to remain there it might be necessary to have legislation. Government institutions running large works should also be forced to take in apprentices and highly-trained scientific men.

Mr. MICHAEL LONGRIDGE (President of the Institution of Mechanical Engineers) said his institution had among its members a large number of manufacturing engineers, who, perhaps more than any other branch of engineers, were vitally interested in the solution of this question. The success of the scheme depended largely on manufacturing mechanical engineers. He could only speak for himself and not for the Council or members of his institution. So long as the proposed committee would confine its activities to advice, consultation, providing schemes for apprenticeship, collecting and disseminating information, but refrain from any attempt to force its schemes into the work, he thought it would be supported by every engineer. The engineering industry was the greatest industry of the country, and the existence of the country depended on its prosperity; but its prosperity depended upon finance. Wages had risen to such a level that the ruin of the industry stood before them unless by increased efficiency and larger output they could compensate by a larger income for the increased expenses. The only way of gaining that efficiency was by a better education, general, technical and religious, and also by supplementing that education by a technical and commercial training. (2) The clause in the memorandum with regard to an information bureau required no argument in its favour. It would bridge over a gap which had long existed. (3) The clause relating to the endowment of scholarships he thought was open to a certain amount of criticism. The scheme was to be supported by contributions from engineers. Manufacturing engineers were already bearing a heavy burden in the time and money they spent on the training of apprentices, and it was a doubtful step to saddle them with the provision of scholarships. That should be a national business worked by the State through the universities and secondary schools, supplemented by the contributions of private citizens.

Mr. C. H. WORDINGHAM (President of the Institution of Electrical Engineers) said as an individual member of his institution he gave his whole-hearted support to the scheme. So far the Council had no details before it, and therefore it was not possible to say they entirely approved of everything that might be done in the future, but the Council had always held most strongly that education was of vital importance to the electrical industry, and he was sure they would always give the strongest possible support to any scheme which promised to promote successful education of engineers. The keynote of that, as of almost all action that would have to be taken after the war, was the co-ordination of existing resources and the co-operation of existing institutions. All petty jealousies and seeking after benefits for individual works must be sunk in the great national effort that would have to be made if this country was to hold its place in the world's markets. He thought this scheme contained the elements of success. He took it this new body would not attempt to arrogate to itself functions which properly belonged to existing authorities and institutions, but that it would be rather an advisory body on the one hand, and an exciting body, on the other. The training and education of the young engineer were largely haphazard and a matter of luck. There was no fixed ideal accepted as being the best training for the engineer, and if this new organisation could lay down lines which were generally acceptable to engineers as a whole that would be an enormous thing accomplished. If also they could co-ordinate the existing educational authorities and bring them into contact with the works they would have attained nine-tenths of what they set out to do.

Mr. W. H. ELLIS (Master Cutler of Sheffield) said it was important that industry should associate itself in the matter. It would only be a success if the industrial houses realised that they had a responsibility as regards their apprenticeships. He would be glad if this organisation led to employers realising that they had a duty to consider the welfare of their apprentices. He hoped to confer with the committee on the details of this question. As an old member of the Cambridge Appointments Board he felt that they had not a proper organisation for allowing the best brain from the university to go forward into the industry of mechanical engineering, and he hoped they would be able to alter that.

Prof. W. E. DALBY (Institution of Naval Architects) said to those who had given a large portion of their lives to the scientific education of engineers that meeting was full of encouragement. Mr. Berriman, the originator of the proposals, was a man of energy and enthusiasm. He represented the employers, and he (Prof. Dalby) hoped the scheme would be carried forward with the energy and enthusiasm of the employers. Not many years ago to have a reputation in an engineering works of scientific knowledge was to be damned, and promotion was impossible. He thought that state of things had passed away, or they would not have had a meeting like that. Ten years ago he went to Charlottenburg to make investigations as to the training of engineers in Germany, and he found there were 10,000 students of engineering over 18 years of age. Many of them before they started on their engineering course were as well educated as many of our people who had taken a degree. He could only find in our universities about 900 men who compared with those 10,000 men. There was not, however, much the matter with the quality of our highly trained men in the engineering profession. He did not think better education could be given in any other country than was given in our universities devoting themselves to engineering training. Before specialising it was necessary to build a strong pedestal of engineering. It was difficult to get employers to take the men who had been educated

scientifically. Sir Alfred Yarrow 10 years ago abandoned the system of pupils paying large premiums, and he paid every man in his works a living wage. That system ought to be adopted all over the country. A good plan was for a man to enter an engineering works and for his training to include three years at a poly. The system was in operation to a certain extent at the Queen's Engineering Works, Bedford.

Lieut.-Com. C. F. JENKIN (Oxford University) said he was with Mr. Berriman in the main principle he had put forward, but there was a lack of information as to what it was proposed to do. Scholarships should be provided by the manufacturers and not the colleges. Manufacturers denied that they were responsible for continuing the student's education.

Sir A. SELBY BIGGE said on behalf of the Board of Education he cordially supported this scheme. He thought the framers of the scheme, and he knew the Board of Education, had definite things in their minds. The Board had always suffered from not having responsible bodies representing the industries with whom they could deal. If the Board did all it could for boys up to 16 years of age, and provided them with a course of education which would be useful to them when they became engineers, would the employers make it worth the while of the boy to be educated up to 16? The Board felt the want of a bureau to which parents could write for advice.

Mr. J. P. BEDSON asked whether it was proposed that the organisation should extend to all apprentices—the young apprentices who were the children of fitters and mechanics, generally in the works. If that was the case he welcomed it gladly. One thing that prevented boys who were fitted to do so from filling the ranks of our capable engineers was that they could not afford to be made apprentices at the wage that was paid—frequently as low as [illegible] a week.

Sir WILFRED STOKES (President of the British Engineers' Association) said his association welcomed this movement. He understood the committee was to be formed of a single representative of each of the institutions mentioned in the resolution. Out of 26 members probably 11 would be manufacturers, and from that point of view he was content to leave them to decide what was to be done.

Sir JOHN WOLFE BARRY, in moving the resolution, said he had been connected with this matter of engineering education about 40 years, and it was a gratification to him to find that such an influential meeting on the matter could be called together. It was only in 1880 that technical education loomed in the eyes of the public in the proportions to which it was entitled. The City and Guilds Institute was erected. Upon that institute he thought upwards of a million pounds had been spent, and some £25,000 a year was still being spent. What he might call the "officers' training corps" of the engineering army was in a very fair way, and he endorsed Prof. Dalby's view that it required very little to be added to it. No university or college could by any system of education fulfil the full requirements of an engineering education—practical experience in a factory or an engineer's office must be added. But with regard to the rank and file of the great industrial army, he was of a different opinion. He thought very much was required. If the young pupils who joined from school were educated pari passu with their practical training we should have an industrial army second to none in the world. But we had not got it now. There had not been that encouragement that there should have been of education in the great manufacturing shops. In what way was that to be given, particularly in view of the requirements of practical work which necessitated a youth beginning work at six in the morning and finishing at five in the evening. The question of how instruction could be given to them required great consideration. It required revision of the hours of labour. He thought those matters could be settled by a representative committee. Different opinions, difficulties and facilities could be discussed, and, provided they wished to arrive at a satisfactory conclusion, a means would be arrived at for educating youth who came from school straight into the works. The whole level of the youths who were going to pursue practical engineering wanted raising, and from that raised level would emerge the great leaders of the future who would direct the industries, and he hoped would do it, as the Americans did, early in life. But they must be fitted for those positions of responsibility, and the object of the organisation they were discussing was to bring about such an education of the youth of this country as would not only provide the leaders, but raise the whole level of the engineering knowledge in the country at large.

Dr. W. H. HADOW, in seconding the resolution, said academic attainments were sometimes actually a bar in the industrial world. But the educational and the industrial classes had gradually converged and the universities adopted their methods to the requirements of the industries amongst which they lived. When the academically trained man did get under weigh in the works he went further than those who had not had their minds trained. The great industrial leaders had now come to the help of the universities and their help had been invaluable.

The Right Hon. A. D. ACLAND (formerly Minister of Education) said the proposed bureau where parents could obtain information would be of great benefit. There was every reason to think Mr. Fisher would bring in soon a scheme of Government scholarships. He (Mr. Acland) was chairman of the consultative committee of the Board of Education to which this matter was referred. The committee considered the question of scholarships mainly bearing on scientific research, and recommended that £100,000 should be expended on scholarships at higher secondary schools, with the object of keeping the students from 16 to 18 years of age. They also recommended that [illegible] £100,000 should be expended [illegible] Government scholarships [illegible]. It was [illegible] promoters of the scheme now under discussion to approach Mr. Fisher before he drew up his estimates [illegible] amount which it was considered was required [illegible].

Other speakers having supported the resolution, it was put and carried unanimously.

THE QUESTION OF NITROGEN FIXATION IN THE U.S.A. FOR PURPOSES OF WAR.*

(*Concluded from p.* 126.)

By-product Ammonia.

This source of ammonia is to-day the chief source of combined nitrogen in all countries, including Germany. Ammonia produced by the destructive distillation of coal when pure is the same as any other ammonia, and can be readily oxidised to nitric acid.

[illegible] which the gas, ammonia and all other by-products are ruthlessly de- [illegible]

[illegible]

[illegible] monia in this country alone. The day is far off before this highly desir- [illegible] cannot be installed by the United States Government for the purpose of [illegible] dental to the production of coke for industrial purposes. Under war [illegible] to-day with over one third of the nitrogen consumed in that country. [illegible]

The use of by [illegible]

[illegible]

* Abstract [illegible]

it appears certain that if the mechanical difficulties are solved, nitrogen will be fixed in this form cheaper than by any other known synthetic process.

NITRIC ACID FROM AMMONIA.

All processes for the synthetic production of nitric acid, except the arc process, involve the oxidation of ammonia. The processes commercially in use involve the direct oxidation of ammonia gas in the presence of air in contact with metallic platinum. In Germany, according to the latest published figures, approximately 100,000 tons of nitric acid are annually produced through the Frank Caro process, which involves passing mixtures of ammonia and air through electrically heated platinum nets of 80 to 100 mesh.

The Ostwald-Barton process first developed at Villevord, Belgium, and brought there to a commercial success at the time of the opening of the war, is now installed in two plage plants, one at Angouleme, France, and the other at Dagenham, England. The present commercial efficiency and output by the Ostwald-Barton process is higher than by any other concerning which exact figures have been obtained.

The processes for the oxidation of ammonia are seemingly free from any complicated patent situation. By the oxidation of ammonia, nitric oxide gases are obtained of much higher concentration than those produced by the arc process. Accordingly, much less tower space is necessary for their absorption, and much stronger acids can be directly obtained by concentration. Although in the arc process the concentration of 30 to 35 per cent. nitric acid to strong acid is required, in the oxidation process an acid of 50 to 55 per cent. strength is easily obtained directly from the towers, and the concentration thereof is accordingly a simpler matter.

OXIDATION OF AMMONIA IN SOLUTION.

A method has been developed in Sweden, details of which are unknown, for the oxidation of ammonia or cyanamide direct to ammonium nitrate in solution. The ammonium nitrate can then be easily concentrated by evaporation, and can be converted to nitric acid if desired. The process seems worthy of very careful consideration, and will be in commercial operation this coming summer, a plant being now in process of erection near Gothenburg, Sweden. A second and much larger plant is also being erected near Berlin, Germany. It is particularly important, because nitrate itself is becoming one of the most important of all explosives.

THE NITROGEN SITUATION.

Owing to the fact that Germany has been cut off from importing nitrate, and has found it necessary to produce huge quantities of combined nitrogen for agriculture as well as for munitions, synthetic processes have made great progress. In the United States, in the event of war, the position would be different owing to various causes. For example, large quantities of fertilisers are used on the cotton crop. War would curtail this crop and also the export of food; consequently, the need for fertilisers would be reduced instead of increased. After the war, Germany will be in a position to produce more synthetic nitrogen than she will require. Also American production of ammonia from by-product coke ovens has increased to a point in excess of the normal consumption. It seems certain, therefore, that the price of combined nitrogen for industrial and agricultural purposes must greatly decrease after the war. Peace time requirements could be supplied from coal tar ammonia with little effect on the market. Thus no serious emergency [illegible] the United States.

COST OF NITRIC ACID.

[illegible] acid, per [illegible], whether as weak nitric acid or as con[illegible] [illegible] by the arc process with hydro-electric [illegible] a cost of \$10 per horse power year, or [illegible] obtained by the oxidation of pure ammonia [illegible] ammonia and must therefore depend [illegible] holders ready to be passed to the [illegible] apparatus.

The cost of ammonia has at the present time no relation to its selling [illegible] absorbing and purifying ammonia [illegible] distillation of bituminous [illegible] by-product [illegible] selling price of by-product am[illegible] with other nitrogenous pro[illegible] wholly by the market price [illegible] competition. [illegible] should [illegible] Haber process at a price as low [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] of combined nitrogen [illegible] producing ammonia synthetically [illegible] industrially applied. The [illegible]

[illegible]

[illegible] nitric acid by the oxidation of ammonia.

[illegible]

The above report was followed by one dated April 20th, by Mr. Parsons, in which the progress of a synthetic ammonia process by the General Chemical Co. is outlined. Also, further particulars are given of the cyanide process. In the former, direct combination of nitrogen and hydrogen takes place at lower pressures than those necessary in the Haber process. It is recommended that a sum of \$3,500,000 be made available to build an experimental plant for this process, and that experiments be carried out on a large scale on Bucher's cyanide process.

The position has been considered by the Nitrate Supply Committee, whose report is dated May 11, 1917 :—

The Nitrate Supply Committee consists of Brigadier-General William Crozier, Rear Admiral Ralph Earle, Brigadier-General Wm. M. Black, Mr. F. W. Brown, Dr. Leo H. Baekeland, Mr. Gano Dunn, Dr. Charles H. Herty, Dr. Wm. F. Hillebrand, Dr. Arthur A. Noyes, Dr. Charles L. Parsons, and Dr. Willis R. Whitney.

The committee recommends :—

1. That the Government enter into negotiations to acquire the rights to use the synthetic ammonia process of the General Chemical Co.

2. That contingent upon satisfactory arrangements with the General Chemical Co., out of the \$20,000,000 nitrate supply appropriation, such sum as may be needed, now estimated at \$3,000,000, be placed at the disposal of the War Department to be used in building a synthetic ammonia plant, employing the said process of the General Chemical Co., and of the capacity of 60,000 pounds of ammonia per 24-hour day.

3. That out of the \$20,000,000 nitrate supply appropriation an amount now estimated at \$600,000, or as much as may be needed, be placed at the disposal of the War Department to be used in building a plant for the oxidation of ammonia to nitric acid and the concentration of nitric acid, of capacity equivalent to 24,000 pounds of 100 per cent. nitric acid and a 24-hour day.

4. That the War Department proceed at the earliest practical date with the construction of the oxidation plant and contingent upon a satisfactory arrangement with the General Chemical Co., also with the Synthetic Ammonia plant.

5. That a form of contract be entered into with the Nitrogen Products Co., and that experimentation looking toward the industrial development of the Bucher process for the production of ammonia be at once proceeded with.

6. That out of the \$20,000,000 nitrate supply appropriation \$100,000 be made available for the active prosecution of investigations of processes for the industrial production of nitrogen compounds useful in the manufacture of explosives or fertilisers.

7. That, in order to increase the production of ammonia and toluol, the Government promote the installation of by-production coke ovens.

8. That the decision as to more extensive installation of nitrogen fixation processes and water-power development in connection with them be postponed.

A statement has also been issued by the Ordnance Office, dated August 21, 1917, summarising the position, reference being also made to the action taken by the National Academy of Sciences and the American Chemical Society.

LEEDS ELECTRICITY WORKS EXTENSIONS.

The city electrical engineer (Mr. C. Nelson Hefford) has submitted an important report to the Electricity Committee recommending further extensions of the Whitehall-road electricity generating station. The committee has adopted the report and has further decided that, subject to the approval of the City Council on the 9th inst., the first part of the proposals outlined in the report shall be put in hand forthwith, this work comprising the installation of a 12,000 kw. turbo-alternator, four boilers, auxiliary plant and buildings, at an estimated cost of £300,000, and the replacement of two 1,000 kw. [illegible] engines and alternators by a 6,000 kw. turbo-alternator at an estimated cost of £35,000.

At the outset Mr. Hefford refers to his 1914 report, which provided for the [illegible] of boiler house, engine house and switch house suitable for [illegible] 36,000 kw. of generating machinery. It was [illegible] should comprise three 12,000 kw. units. The [illegible] report were approved and work was commenced on the first portion of the scheme, which consisted of constructing and equipping half the boiler house, one third of the engine house and switch block [illegible] circulating pump house, &c. The first portion was estimated [illegible] and the complete scheme £150,000, but owing to [illegible] during the construction, the estimate for the first portion has been exceeded by approximately £25,000, owing entirely to the [illegible] of the buildings. Though many delays have been met with the work [illegible] completed by the end of the year.

[illegible] 1914 proposals certain work remains to be executed, including the [illegible] of the three buildings referred to above, and the [illegible] generating plant. In addition the scheme involved the extension of the offices along that portion of the site which fronts on W[illegible]-road. The work remaining to be done is of considerable [illegible], involving important capital expenditure, but in

view of the large electrical developments that are taking place, and which expert opinion considers as a solution for many of the after-war difficulties, it is now necessary for the Committee to consider what steps should be taken with regard to further extension of the undertaking. When considering the amount of actual growth with a view to the provision of plant to meet an estimated demand, it is necessary to consider under present circumstances how far the load which has already been attained has been influenced by the extraordinary conditions arising during the war. It is natural to suppose that at least some of the increase is directly due to the erection of new factories or the extension of older ones utilised at present solely for producing munitions. It is a matter of speculation as to the extent to which the demand which has arisen from these sources will be of a permanent character. This consideration faces all large industrial centres in connection with their electricity supply undertakings. There are instances where extraordinary extensions of generating stations are being carried out to meet the huge growth in demand for electricity for power which has arisen in late years. Many of the large industrial communities in the country are at the moment either involved in or are considering large schemes of extensions for their electricity undertakings. For example, Manchester, Bradford, Sheffield, Birmingham, Glasgow, Edinburgh, Rotherham, &c., have embarked or are on the point of embarking upon schemes involving a total spending of several millions of pounds. Notwithstanding a suspicion that in some of these cases a part of the extraordinary growth will fall off at the conclusion of the war, ruling authorities have recognised for themselves the absolute necessity of providing an adequate and efficient supply of electricity. In the case of Leeds, there is reason for congratulation in that so far the electricity undertaking has not been subjected to the installing of additional plant to meet any extraordinary demand arising out of the war. The extension now practically completed was one decided upon before the war to meet an expected demand, and the suggestions contained in the report do not at all accelerate the time for completion of the Whitehall-road works. The probable reason for the small number of new factories is that the existing engineering works in the City were of such a type that they could readily cease manufacturing their pre-war specialities. In some cases this has led to an actual diminution in the demand, whilst in others it has increased, but there is no reason to anticipate any general reduction if the trade of the country is maintained when such firms once more take up their pre-war manufactures. In connection with the works which have been indicated as being specialy constructed, in all cases these are of a permanent character erected closely adjacent to existing works and have been laid out with a view to their ultimate use as engineering workshops, and there is every reason to anticipate that notwithstanding possibly a brief interval, they will be ultimately fully occupied. It is reasonable to conclude, therefore, that the great bulk of the increase is of a normal character, consisting in many cases of the carrying out of orders for the supply received before the war, and, in other cases, of electrifying works whose owners have satisfied themselves as to the suitability of the Corporation supply for their purpose.

(Continued on page 178.)

LEGAL INTELLIGENCE.

Osram Lamp Patent Litigation.

On Oct. 25 the House of Lords gave their considered judgment in the appeal by the Osram Robertson Lamp Works, Ltd. [illegible]

[illegible]

relating only to the solution to be employed for cellulose, and as meaning that the cellulose was to be dissolved in chloride of zinc or cupreous ammonia oxide or any like solution, or as relating to the whole of that limb of the clause from "such as collodion" to "oxide" inclusive; for the present purpose it was immaterial which of those constructions was adopted. [illegible] usual manner. [illegible] to be subjected to heat in the absence of oxygen as in the manufacture of charcoal, so that the other materials were driven off by destructive distillation and the carbon was left. The specification added: "In some cases after denitration has previously been effected"; but denitration was obviously no essential part of the process, and was to be employed only if it was wanted. The specification went on to direct that the filaments were to be subjected to the following further treatment: First of all the carbon which has only served as a binding medium is removed by subjecting the filaments to the passage of current in an atmosphere of steam and hydrogen, and thus raising it to a high temperature. By this means the carbon is completely oxidised so as to form carbonic oxide, and the filament of tungsten is left." It was mainly upon this last passage that the question of infringement depended, for defendants did not heat the filament by passing the electric current through it, but by the agency of external heat, and they did not subject the heated filaments to an atmosphere of steam and hydrogen formed ab extra; but it was alleged by appellants that such an atmosphere was created ab intra by the heat, and that respondents' process was in substance that of appellants'. The next sentence in the specification related to the method to be adopted for equalising the filaments. The claims in the specification were clearly confined to the application of the process described to tungsten and its compounds for the purpose of producing incandescent bodies for lamps. The Court of Appeal dealt first with the question of infringement, and as they arrived at the conclusion that there was no infringement they considered its unnecessary to express any opinion upon the question of the validity of the patent. In his Lordship's opinion respondents' process did amount to an infringement of appellants' patent. He arrived at that conclusion by comparing by the light of scientific evidence the process described in appellants' patent with that pursued by respondents according to the admittedly correct description given it by Dr. Passmore in his evidence. The great merit of appellants' patent consisted in the discovery that tungsten could be successfully used for the manufacture of filaments for electric lamps. Respondents, like appellants, used tungsten for that purpose, but said that they did so by a process different from that of appellants'. As all that appellants claimed was the manufacture of tungsten filaments by the process described in their specification, it was necessary to consider in detail the processes adopted by appellants and respondents respectively. Having dealt with the respective processes employed by appellants and respondents, his Lordship said it was claimed for respondents that there were advantages in their process which were not possessed by that in the terms of appellants' patent. He thought that that was the case, and that there were improvements in the process followed by respondents as compared with that under the patent. But the fact of improvements did not cure the fact that respondents' process was substantially one which employed an atmosphere of steam and hydrogen. The patent, no doubt, contemplated the creation of that atmosphere ab extra. Only the hydrogen in respondents' process [illegible] by the action of the hydrogen on the oxide of tungsten forming water—a fact which was well known. That difference did not, in his opinion, [illegible] unnecessary to say anything further about the second process of respon- [illegible]

But there remained [illegible]

chloride of zinc or cupreous ammonia oxide), the patent would be bad. The solution of cellulose in cupreous ammonia oxide might be used with tungsten compounds, such as tungstite, tungstic acid or synthetic sulphur, but not with tungsten itself. It followed that if the specification directed that it might be so used the direction was misleading and the patent would be vitiated. The specification must be read as it would be understood by anyone having a competent knowledge of the industry. The evidence established that it was well known in 1904 to everyone who had experience in making filaments that if cupreous ammonia oxide were used as a solvent for cellulose the result would be a failure if the metal tungsten were used with it. That was proved at a very early stage of the case by Dr. Passmore. Upon that evidence he had come to the opinion that the patent was valid and infringement had been established. The appeal ought, therefore, to be allowed.

Lord HALDANE's judgment, which was read by Lord Dunedin, was in favour of the appeal being dismissed, as in his view there was no infringement by respondents, and the patent was bad for want of subject-matter and misleading description. In comparing the two processes, his Lordship pointed out that respondents' mode of manufacture, unlike that of appellants', did not require free carbon at any stage. That disposed of the case for infringement, for no other serious point had been raised under that head. He agreed with the observation which Lord Justice Warrington had made in concluding his judgment in the Court of Appeal. In other words, appellants' patent was one only for a process in which known factors were combined in a particular fashion. The novelty lay in the fashion of combination, and the fashion of respondents' combination was of a substantially different character, to which the doctrine of equivalents had no application. The question of validity mainly depended upon whether the direction in the patent was wrong. And it was wrong if it said something would do that which it would not do. Now, even if that were otherwise, the direction in the present case was addressed, not to chemists, but to skilled lampmakers, and a skilled lampmaker must be furnished with practical guidance as to what to avoid which might have to be in excess of that which a chemist would need to put him on his guard. With that observation, after quoting the directions in the specification, he said he was unable to read it excepting as, among other things, telling those to whom it was addressed that they might take finely divided tungsten and mix it with cupreous ammonia oxide. If that were a method prescribed, it was admitted that it would not work. It was said that anyone with competent chemical knowledge would know the fact and avoid the method. But even it such chemical knowledge, however general and practical, could be attributed to lampmakers, which he doubted, the direction sinned against the light and was bad. Cupreous ammonia oxide worked with tungstic acid, and, according to the evidence, he thought also with commercial tungstic sulphide, which consisted of the disulphide, a little trisulphide and some free sulphur. It was, therefore, immaterial that it did not work with pure tungstic trisulphide, which was not the ordinary article of commerce. But, as the direction in regard to the tungsten itself was bad, the specification must, in his opinion, fail on the ground of insufficiency. For he was [illegible] modified by the introduction of the words [illegible] as to mean that the persons to whom it was addressed were to be on their guard and to discriminate before they used the cupreous ammonia oxide. The instruction in regard to tungsten itself appeared to be unambiguous, and consequently fatal to the validity of the patent. For these reasons he thought the appeal failed.

Lord [illegible], who read Lord Parker's judgment, said he agreed with the reasons given by that noble lord for allowing the appeal, and it was unnecessary for him to deliver a separate judgment of his own.

[illegible] took over an hour to read, but the following [illegible] Upon the evidence he thought he was bound [illegible] had infringed the patent. They had mixed tungsten with an organic binding material, and from the mass thus made [illegible] These filaments they had [illegible] the carbon chemically, substantially [illegible] They had, it was true, substituted a [illegible] mode of heating, and thus avoided [illegible] but there was in his opinion no sub- [illegible]

at the date of the patent, to the manufacturers of artificial silk. The fact that metal would not work in a solution of cellulose in cupreous ammonia was not known to Mr. Ballantyne, the chemist, called on behalf of respondents, who said that he had tried cupreous ammonia cellulose with tungsten metal without success. That cupreous ammonia was a solution perfectly well known in 1904, but that it was not known to him that any metal in cupreous ammonia cellulose would decompose, and that he discovered it, along with Dr. Hehner and Mr. Swinburne in his experiment in the present case. He had come to the conclusion that the patent was not valid; but, having regard to the long argument on the question of infringement, and on which he agreed in the conclusions of the Judge of first instance and of the Court of Appeal, he proposed to consider that second issue. Having compared the two processes, his Lordship said he had prepared an analysis of what appeared to him the results to be obtained from the experiments; but he had had the opportunity of reading the opinion under that head expressed by Viscount Haldane, and, acquiescing in that opinion, he would not trouble them with an unnecessary repetition. He thought that the true conclusion was that, though to a certain extent steam in the presence of hydrogen did react to oxidise the carbon in the process of respondents, yet that that was an incident which, though it could not be certainly avoided, was not in reality the reaction on which they depended for the success of their process, and that, in substance, the process of respondents was a different reaction—namely, that between carbon and the oxygen in the tungsten oxide. He did not doubt that a similar reaction took place in the process of appellants, but it was not claimed as part of the patented process, and there was no suggestion that that reaction was, as a distinct process, within the monopoly of the patent.

On the motion of the Lord Chancellor, the appeal was allowed, with costs there and below.

Counsel: For appellants, A. J. Walter, K.C., H. A. Colefax, K.C., and J. H. Gray; for respondents, Thos. Terrell, K.C., E. M. Kerly, K.C., and E. Russell Clarke.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The [illegible] from some of the specifications recently published have been [illegible] Messrs. Mewburn, Ellis & Pryor, Chartered Patent Agents, [illegible], London, W.C.

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1915 SPECIFICATIONS.

14,42[illegible] [illegible] response line and reporting devices for use with telephones. (30/6/13.)

1916 SPECIFICATIONS.

[illegible]473 [illegible] & P[illegible]linkowsky, L. Machine switching telephone exchange systems. (15/6/16.) 109,456.

12,505 FOREST, L. DE. Radio transmitter systems. (4/9/15.) 101,415.
A radio transmitting system, including an oscillion for generating electrical oscillations, and a microphone connected in shunt with said oscillion, and forming part of a high resistance leak path connected between two electrodes of the oscillion, whereby the amplitude of the oscillations produced may be varied.

12,687 BOVING, J. O. Electric furnaces. (7/9/16, cognate application 2,807/17.) [illegible]

13,121 B.T.-H. Co. (G.E. Co.) Charging systems for storage batteries. (15/9/16.) 109,485.

13,11[illegible] [illegible] D[illegible] electric machines. (2[illegible]/9/15.) 101,554.

16,008 B.T.-H. Co. (G.E. Co.) Method of and process for making magnetic material. (8/11/16.) 109,528.
A process of making low hysteresis, high permeability and non-ageing magnetic material, which consists in subjecting commercial iron to a high temperature under a gas pressure at or below the dissociation pressures of the oxides of the iron for the pre- [illegible]

17,464 B.T.-H. Co. (G.E. Co.) Glass blwoing apparatus. (5/12/16.) 109,544.

1917 SPECIFICATIONS.

[illegible] M[illegible] 109,76[illegible].

10,354 GOLDSTONE. Portable dry battery electric torches. (18/7/17.) (Addition to 2,036/15.) 109,776.

APPLICATIONS FOR PATENTS.

[illegible]

September 24, 1917.

[illegible]

Operating and carrying electric flash lamps.

[illegible]

13,7[illegible]

[illegible]

13,780 W[illegible] (2/14/17. U.S.)

[illegible] installations. (25/10/16. U.S.)

[illegible]

Osram
G·E·C·
DRAWN WIRE
Lamps
OSRAM
PATENT
G·E·C
MADE IN ENGLAND
MAKE
SURE
IT'S AN
OSRAM

COMMERCIAL & INDUSTRIAL SECTION.

Technical and Commercial Libraries.

An interim report by the Council of the Library Association on the provision of technical and commercial libraries has been issued. The report includes some tentative recommendations, including the following:—

1. (a) The removal of the existing limit to the library rate, so that local authorities may be free to [illegible] libraries the sums necessary for their greater efficiency.

(b) A closer union between state and copyright libraries and municipal libraries, so that the resources of the former [illegible] directly or indirectly be more available for scientific and technical students in the provinces.

(c) That funds should be provided for some state-supported library, such as the Science Library of South Kensington, or a library controlled by the Department of Scientific and Industrial Research, to purchase books for research and to make them available for loan to public libraries.

2. The Council have ascertained that most libraries possessing a full set of patent specifications prefer to continue to receive all rather than a selection of classes. Some other libraries not receiving the full grant would be glad to obtain the classes of most service to the industries of their areas, but the Patent Office authorities do not recommend this course; for the present then these libraries must rely upon the Abridgment Series and the "Illustrated Journal." Few libraries, however, possessing the Abridgment Series receive either the advance sheets of the period in course of publication, or the series of the fifty years' subject-[illegible]. Both of these publications are of material value for search purposes. They may be obtained on application to the Comptroller-General of Patents. Some expenditure and clerical labour, however, are involved in casing and filing these sheets in class order, and in some cases it might be advisable to apply for a selection of classes most in request in [illegible] district.

3. Certain recommendations are implied in the above account of the [illegible] work. As in future public libraries must probably devote a larger proportion of their resources to work more directly useful to industry and commerce, the Council are of opinion that it is of urgent national importance to increase the supply of scientific and technical books and [illegible] [illegible]

[illegible]

(c) That a State scientific or technical library should publish periodically [illegible]

[illegible] by the increased provision of current indexes and digests.

4. In the interests of the domestic and foreign trade of this country, it is desirable to establish commercial departments in libraries in trading [illegible]

[illegible]

• • • •

Canadian Electrical Exports.

[illegible]

Welfare Work Among Boys.

At the [illegible] which was held at the Ministry of Munitions last week, Mr. W. L. Hichens said it was intolerable that any employer should think that he had done his duty when he had paid his men their wages, and that he had [illegible]. There must be something beyond that cold economic consideration which bound employer and workmen together like prisoners.

It was [illegible] but they must beware of grandmotherly interference, of trying to force themselves into the lives of the men whom they employed. It was an essential part of welfare work that they should try to develop real education in the works, as well as the best system of training.

Mr. R. A. [illegible] constantly changed their employment, often at the ruin of their career.

Mr. A. P. M. Fleming [illegible] referring to the education and apprenticeship of boys, explained that the object of the system at the Manchester works of his firm was to develop the mental, moral, and physical characteristics of the youth to the greatest possible extent. The education of boys should be continued during working hours, and he suggested that there should be eight hours a week of continuous education for 14 weeks in a year. The alternative was a well-equipped works school.

Mr. E. S. R[illegible] "future of welfare," and the nature of the work that lay before the supervisors. [illegible] any firm foundation on which a proper system of welfare could be [illegible] [illegible] mensely improved methods of organisation and of work, better equipment in their factories, and a much larger application of science. They must [illegible] was not far distant when they would see a universal eight hours day.

• • • •

British Dyes Progress.

In the annual report of British Dyes [illegible] total share and loan capital at April 30 was [illegible] dividend at the rate of 6 per cent. per annum (the maximum amount [illegible]

[illegible]

construction of the main research laboratory at Huddersfield will [illegible]

[illegible]

• • • •

Platinum in the U.S.A.

The United States Geological Survey [illegible] quantity of platinum [illegible]

[illegible]

believed that [illegible]

ELECTRICITY SUPPLY.

EXTENSIONS.

Bedford.—Negotiations are proceeding for the supply of electrical energy for power by the Council to the works of Cryselco, Ltd.

The estimated cost of the cables, &c., is £3,835 and the consumers have been asked to pay £2,420 towards the cost and to guarantee a minimum revenue of £550 a year for 7 years.

Similar applications have been received from three other firms. The Committee also reported that Messrs. Allen's demand exceeded the rated capacity of the three cables laid to the firm's works, resulting in undue "mains losses," and it was necessary to lay a fourth cable immediately, but a fifth cable would be laid for extra safety, for which Messrs. Allen were willing to pay a rental of £50 per annum. The firm's demand was likely to increase by 25 per cent. in the near future and they had also applied for an additional cable to be laid between Queen's Works and the Biddenham Works.

Grimsby.—The proposed extensions of the electricity works, which are estimated to cost about £25,000, will not be proceeded with until the end of the year, when the peak load battery scheme will be carried out.

Leeds.—Important extensions of the electricity works, estimated to [illegible], are recommended by the Electricity Committee. [illegible] of the engineer (Mr. C. Nelson Hefford) is given on another page.

Leicester.—[illegible] the Tramways and Electricity Committee [illegible] report to the Corporation recommending the [illegible] and the erection of new electricity works at a cost of about £250,000.

The extensions are necessary in order to meet the increasing demand for electrical energy for power, and it is therefore proposed to apply to the Board of Trade for a provisional order. Anticipating the adoption of this recommendation, a special meeting of the Council has been summoned for the 27th inst. to consider and, if deemed expedient, to adopt a resolution in favour of applying for an order to acquire compulsorily [illegible] a certain piece of land containing over 32½ acres for the proposed new station.

The Report was adopted.

GENERAL.

Electricity Supply in Greater London.—Meetings have been held of the Conference of Local Authorities owning electric supply undertakings in Greater London.

At the first meeting 24 authorities were represented, and it was resolved [illegible] Board of Trade Electric Power Supply Committee [illegible] from the Conference with respect to the supply of electrical energy in Greater London by local authorities."

[illegible] committee consisting of three municipal [illegible] Town Clerks and three engineers to prepare [illegible] to be elected from the Outer London authorities.

On the invitation of the L.C.C. Special Electricity Committee, it was [illegible] to meet the L.C.C. Committee to discuss [illegible] arrived at by the Board of Trade [illegible].

[illegible] represented at the Conference has been asked [illegible] the expenses of the Conference. At [illegible] that the Board of Trade Committee [illegible]. It was resolved that the Committee [illegible] municipal representatives [illegible] the L.C.C. Special Committee [illegible] the Outer London authorities to be included [illegible] from the following authorities [illegible] Ilford and Walthamstow.

Halifax.—[illegible]

Heston and Isleworth.—The Urban Council [illegible]

Kingston-on-Thames.—[illegible]

London County Council.—[illegible]

Luton.—[illegible]

LIGHTING AND INDUSTRIAL POWER.

Bristol.—As electric lamps for street lighting can be extinguished within 15 minutes of warning being given, the Council has been authorised to introduce improved street lighting at once. This concession does not apply to the gas lamps.

Eastbourne.—In order to meet the demand for more light, and to ensure prompt extinction in emergency, it has been decided to convert the gas lamps into electric lamps along the main streets.

Edinburgh.—The Electric Lighting Committee recommend that a charge of £50 for the inspection of the lights in picture houses and places of entertainment in the city, undertaken by the Committee and ordered by the Magistrates, should be met by the Streets and Buildings Committee, as the Committee charged with the safety of the public.

Equipment of Ports.—The Port of Genoa has 25 electric transhipment elevators for the automatic discharge of coal and other goods in bulk, each capable of unloading about 50 tons of goods per hour; 120 hydraulic and electric cranes; 10 electric winches; 6 pneumatic pumps for the grain docks, with a capacity of 500 tons per hour, with a subsidiary pneumatic apparatus for the discharge of grain; several floating cranes, ranging from 30 to 160 tons load.

New Coaling Plant at Durban.—The new coaling plant erected at Durban is of the most up-to-date pattern. It is electrically driven, is worked by a belt conveyor designed for a discharge capacity of 600 tons per hour. A special feature of the new plant is its flexibility and adaptability to vessels of various sizes and designs. The new and old plants working together can coal three vessels simultaneously.

Workhouse Lighting.—Loughrea Guardians recently agreed to pay an increase in the charge for electricity for lighting from 6d. to 8d. per unit, but the L.G. Board have declined to sanction the increase, as they do not consider that "as trustees for the ratepayers the Guardians can legally increase the price agreed upon with the local electric light company in 1914."

ELECTRIC TRACTION.

Dewsbury.—Owing to shortage of staff the forenoon tramcar service between Dewsbury and Earlsheaton has been suspended by the Dewsbury, Ossett and Soothill Nether Tramways Co.

Electric Vehicle Progress.—In the annual report for the year ended March the Sheffield Health Committee states three additional electric vehicles were put into service during the year, and orders have been placed for five more.

Further experience has confirmed the favourable opinions expressed last year as to the value of the vehicles in refuse collection; in fact, had it not been for their use, the work of the department must have become hopelessly in arrears. The results of the year's working show conclusively that by the use of electrics the work can be done more effectively, economically, and with less workmen than by horses.

In comparison with the average cost by horse labour over the whole city, the electrics show a saving on bin refuse collection of 8·8d. per ton and on ashpit refuse of 1s. 7·2d. per ton. It is stated that there is little doubt that it is to electricity as a motive power for transport vehicles engaged in town collection and delivery work, that the future must look for a solution of many of the present day difficulties. Garage accommodation has been provided at Wortley road and Penistone road depots, and charging facilities provided for a greatly increased fleet of vehicles.

At the last meeting of Norwich City Council a long report from the Health Committee on the collection of house refuse, &c., was adopted.

The committee submitted alternative proposals for a one-destructor and a four-destructor scheme, but recommended the latter. In the four-destructor scheme each destructor would act as a collecting centre, and so effect a small economy in collection. Four collecting centres would cost £1,500 each, or (including sites) £6,000; five 4-ton electric motor wagons at £1,200 each, £6,000; purchase of 58 acres of land and [illegible] £4,000. Estimate of annual cost: Interest and sinking fund on £16,000 (at average of, say, 10 per cent.), £1,600; rates, &c., £240; labour and maintenance of four collecting centres, £800; labour on tips, £100; [illegible] tons transported an average of 2½ miles [illegible], five motor lorries [illegible] at 3½d. per ton per mile of the double journey, [illegible]; [illegible] of 50 acres of land not in use for tipping at [illegible] per acre, £100; total, [illegible]. To this must be added £5,230, the cost of [illegible] collection, making an annual expenditure of £10,200.

L.C.C. Tramways.—At Tuesday's meeting of the London County Council, the Highways Committee reported that it considered it inopportune to appoint a permanent publicity assistant. It was decided, as a temporary measure, to engage a woman to assist in publicity work.

Manchester. The minutes of the Tramways Committee submitted to the Council on Wednesday, contained a report by Mr. J. M. McElroy on the financial position of the department.

In the course of his report Mr. McElroy states that while the income for the half-year shows a large increase (£37,126) on the corresponding period last year, the expenditure had increased at a greater rate than the income, and the surplus for the half year (excluding provision for renewals) was £88,673, against £90,409. [illegible] now to face much larger increases in the expenditure. The recent arbitration awards, granting further war bonuses to the employees, would cost the department £45,000 per annum. That will make the total amount payable as war bonuses and war service allowances [illegible] £200,000 per annum. The payment of those large sums has in the past been made possible by adopting the unsound policy of utilising the moneys which should have been paid into the renewals fund. But in the future (if nothing was done to increase the revenue) even the continuance of that unsound policy would not suffice to meet the situation. The renewals fund depleted as it had been, would have to be drawn upon to meet the [illegible] Mr. McElroy [illegible] the department has not yet reached the high-water mark as regards increased expenditure, which [illegible] present steps are taken for securing additional revenue by increasing the [illegible]

Newcastle-on-Tyne. At last week [illegible] the Tramways [illegible] were decided upon. Fuller services are to be given [illegible] [illegible] been discontinued.

Newport (Mon.). The Board of Trade [illegible] Newport [illegible] 1917 [illegible] Newport.

TELEGRAPHY AND TELEPHONY.

Wireless Station in Buenos Ayres Province. [illegible] been erected under the supervision of Siemens-Schuckert (Ltd.) in [illegible]

[illegible] many clearly and distinctly.

Wireless Telegraphy at Spitzbergen. [illegible]

Wireless Telegraphy on Ships. [illegible]

IMPERIAL NOTES.

Australasia. [illegible]

British New Guinea. At the [illegible] Mr. W. A. [illegible] to lay the railway to Sapphire Creek, when the rails, bought expressly for the purpose, arrived at Port Moresby towards the end of 1914. That work had not yet been commenced, but they hoped it would be undertaken before long. The railway undertaking should itself [illegible] be transmitted to Port Moresby at very small cost.

Canada. H.M. [illegible] deposits of manganese dioxide discovered in the Cypress Hills, [illegible] tons of ore.

[illegible] analysis of the latter ore shows 42 per cent. of metallic manganese.

New Zealand. [illegible] with a new electric storage battery truck, of American manufacture, intended for use on the waterfront.

[illegible] wheels placed underneath the body. Forty-two Edison type batteries are carried under the platform. The batteries are capable of running the truck for a full working day, and the electric motor is controlled [illegible]

Queensland's Rare Metals. [illegible] agency to handle rare metals.

[illegible]

FOREIGN NOTES.

Chile. [illegible]

China. [illegible]

The building of the new electric light company's works north of Changsha is proceeding rapidly.

Peru. [illegible]

Russia. [illegible]

MISCELLANEOUS.

Appeal to Motor Lorry Owners. [illegible]

Motor [illegible]

British Association of Chemists.—It was recently decided to form a provisional committee to consider the definition and professional status of the chemist and to formulate proposals to form a British Association of Chemists. A further meeting has been called for the 10th inst. for the purpose of forming the Association defining its [illegible], &c.

Coal Prices.—Bradford Electricity Committee has authorised the Town Clerk to protest to the Coal Controller against making the increased price of coal retrospective as from the 17th ult. as far as works and undertakings are concerned, and that he urge the Coal Controller to bring the coal supplied to works and undertakings into line with the coal supplied for house purposes.

Customs Decisions.—The duty upon insulating tape imported into Southern Rhodesia by importers of electrical material and to [illegible] purposes is 5 per cent. ad val. under the general tariff. British goods being admitted duty free.

Enemy Firms Wound Up.—Claims against the United Carborundum & Electrite Works (Ltd.) and against the Vincit Co. (Ltd.) are to be sent by Nov. 30 to Mr. Chas. Eve, Capel House, 62, New Broad-street, London, E.C.

New Book.—Messrs. Longmans, Green & Co. announce that they have in the press a new book on "Telegraph Practice," by Mr. John Lee, who was until recently the Deputy Chief Inspector of the Telegraph and Telephone Traffic Section in the Secretary's Office, G.P.O., London.

Will.—The late Mr. William R. Sykes, railway signal engineer, [illegible] estate which has been valued at £16,815.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during September, 1917, and (*b*) the aggregate figures from Jan. 1 to September 30, with increase or decrease compared with corresponding periods of 1916:—

Electrical machinery, (*a*) £115,694 (increase £11,237), (*b*) £1,047,300 (increase £133,805) [illegible] generators and motors other than for [illegible] and cycles, (*a*) £13,959 (decrease £10,823), (*b*) £189,403 (increase £23,647); and electrical machinery unenumerated, (*a*) £101,735 (increase £22,060), (*b*) £857,897 (increase £110,150); telegraph and telephone cables other than submarine, (*a*) £88 (decrease [illegible]), (*b*) [illegible] (decrease £9,722); telegraph and telephone apparatus, (*a*) £3,495 (decrease £2,511), (*b*) £24,861 (decrease £181,837); other electrical wires and cables, rubber insulated, (*a*) £1,309 (decrease [illegible]), (*b*) £31,763 (decrease £60,044); with other insulations, (*a*) £120 (decrease £5,354), (*b*) £8,650 (decrease £3,874); carbons, (*a*) £8,323 (increase [illegible]), (*b*) £92,716 (decrease £4,700); glow lamps, (*a*) £160 (decrease £28,172), (*b*) £65,807 (decrease £154,840); arc lamps and electric searchlights, (*a*) [illegible], (*b*) £97 (increase £97); parts of arc lamps and searchlights (other than carbons), (*a*) £5,600 (decrease £5,036), (*b*) £91,779 (increase £11,220); primary and secondary batteries, (*a*) £20,128 (increase £1,453), (*b*) £232, 701 (increase £84,129); meters and measuring instruments, (*a*) £2,913 (decrease £1,567), (*b*) £25,610 (decrease £13,894); switchboards, (*a*) nil, (*b*) £481 (increase £224); electrical goods and apparatus unenumerated, (*a*) £52,407 (increase £13,756), (*b*) £405,851 (increase [illegible]). Total of electrical goods and apparatus other than [illegible] and unenumerated wire, (*a*) £94,513 (decrease £38,036), (*b*) [illegible] (decrease £189,975).

Exports.—[illegible] of electrical machinery, material, &c. (*a*) during September, 1917, and (*b*) from Jan. 1 to September 30, with [illegible] compared with corresponding periods of 1916.

[illegible]

TENDERS INVITED AND ACCEPTED.

Train Lighting Cells.

Tenders will be received by the Tender Board, SOUTH AFRICAN RAILWAYS, Johannesburg, until noon, Nov. 12, for the supply of 4,466 train lighting cells.

Wiring and Fitting.

Tenders are required by Nov. 5 for the electric lighting of the Central Tuberculosis Institute, Durham-street, BELFAST. Specification, &c., from the City Electrical Engineer.

Railway Stores.

The GREAT NORTH OF SCOTLAND RAILWAY Co. require tenders by 10 a.m., Nov. 22, for six or 12 months' supply of stores and materials, including telegraph material, boiler tubes, steel, castings, ironmongery, oils, &c. Forms of tender from Stores Superintendent.

BRADFORD.—On Tuesday the Corporation accepted the tender of C. A. Parsons & Co. for the supply and delivery of a 12,000 kw. turbo-generator at the Valley-road electricity works at £45,775. It was also decided to place an order for a condenser.

EAST HAM.—The Town Council has accepted the tender of Edison Accumulators (Ltd.) for six electrically propelled dust vans at £1,121 each, and one automatic electric filler at £2 10s.

GLASGOW.—The Tramways Committee has accepted the tenders of the Liverpool Electric Cable Co. and the British Insulated and Helsby Cables (Ltd.) for the supply of cable.

HEREFORD.—The Corporation has placed an order for the supply of electric motors and pumps with Mather & Platt, at £736.

ILFORD.—The Urban Council has accepted the following tenders:—General Electric Co., D.C. switchboard for sub-station, £286 10s.; h.t. switchgear, £174; additional equipment for switchboard, £72 10s. 7d. Herbert Morris (Ltd.), 7½-ton overhead travelling crane, £106.

LONDON COUNTY COUNCIL.—The following tenders have been accepted:—

British Insulated & Helsby Cables, 3,724 yards of trolley wire, £396. 2s.; Morgan Crucible Co., carbon brushes for electrical equipment, £295.

Government Contracts.—The following tenders were accepted by the British Government Departments during September:—

[illegible] F. A. Lister & Co., generating sets; Electric Construction Co., F. [illegible]son & Co. and Rhodes Motors (Ltd.), motors; Harland Engineering Co., transformers.

India Office.—Crompton & Co., alternators; Siemens Bros. & Co., cells and gutta percha J. Stone & Co., cells and dynamos.

H.M. Office of Works.—Lund, Bros. & Co., wiring court house, Newington Causeway, London; Harland Engi. Co., generating plant for Ordnance Survey (overhead office).

Post Office.—Automatic Telephone Mfg. Co., General Electric Co., India Rubber, Gutta Percha [illegible] Telegraph Works Co., Telegraph Condenser Co. and H. White & Co., telegraph apparatus; British L. M. Ericsson Mfg. Co., General Electric Co., and Western Electric Co., telephone apparatus; Telegraph Construction & Maintenance Co., submarine cable; Connolly Bros., telegraph cable; British Insulated & Helsby Cables, Callenders Cable & Construction Co., Ltd., W. T. Glover & Co., W. T. Henley's Telegraph Works Co., Johnson & Phillips, C. Macintosh & Co., Peel Conner Telephone Works, Siemens Bros. & Co., Union Cable Co., and Western Electric Co., telephone cable; Siemens Bros. & Co. leclanche cells; Eyre Smelting Co., zinc rods; British Insulated & Helsby Cables, Shropshire Iron Co., and F. Smith & Co. (inc. in London Electric Wire Co. & Smiths), bronze wire; British Insulated & Helsby Cables, copper binding wire; Concordia Electric Wire Co., covered copper wire; T. Bolton & Sons, British Insulated & Helsby Cables, Elliott's Metal Co., Johnson & Nephew, Shropshire Iron Co., F. Smith & Co. (inc. in London Electric Wire Co. & Smiths), Wilkes, Sons & Mapplebeck, copper line wires; [illegible]

APPOINTMENTS VACANT AND FILLED.

Engineers, with sound mechanical training and with experience of large power stations, are wanted immediately by a Government Department for the duration of the war; also electrical engineers with experience of the latest practice in factory equipment. *See an advt.*

Applications are invited for the position of Principal of the Coventry Municipal Technical School. Commencing salary £600. Particulars from the secretary (Mr. Frederick Horner), Education Department, Council House, Coventry. Applications by Dec. 1. *See advertisement.*

A junior shift engineer or improver is required for a large power station in the north. *See advertisement.*

Manchester Electricity Committee require a shift engineer. Commencing salary about £220 per annum. Applications to the Chairman of the Committee by 10 a.m., Nov. 5.

Fleetwood Urban Council require a chief assistant engineer at their electricity works. Salary £150, increasing to £175. Applications to the Clerk to the Council by Nov. 6.

An assistant is required in the mechanical and electrical engineering department at Halifax Municipal Technical College. Particulars from the Principal or the Secretary.

An assistant electrical engineer is required at Buxton electricity works. Applications by Nov. [illegible], to Mr. [illegible] Taylor, Town Hall, Buxton.

Mr. E. H. Decker, second class assistant in the L.C.C. tramways, has been appointed time-tables assistant at £262. 10s. a year.

Mr. [illegible] has been appointed [illegible] foreman at Heston [illegible] at £[illegible] per annum.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Blackpool. The accounts of the electricity department for the year ended March 31 show gross capital expenditure £252,191 (increase £2,140), of which £78,678 has been redeemed. The sinking fund amounts to £54,583.

Revenue was £47,038 (compared with £44,746 in previous year) and working and general expenses were £28,771 (£25,276), leaving gross profit £18,267 (£19,070). Interest and sinking fund required £17,909 (£16,592), leaving net profit £358 (£2,478). Units generated were 5,957,000 (5,484,000) units.

The capital expenditure on the tramways is £300,879 [illegible]. Sinking fund amounts to £148,954, reserve to £9,142, and renewals fund to £30,542. Revenue was £96,224 (£80,666), and expenses were £55,085 (£45,030), leaving gross profit £41,139 (£35,636). Loan charges were £19,956 (£18,761), and net profit was £21,183 (£16,275), of which £2,183 (£3,275) has been [illegible] £9,000 to permanent way renewals fund, and £10,000 (£5,000) to relief of rates. Average total revenue per car mile was 20·01d., and working expenses, including power, were 11·29d. Passengers carried were 17,810,538, car-miles run 1,131,728, and units used 1,812,488.

East Ham.—At March 31 the capital expenditure of the electricity department was £156,175 (increase £461) (including £15,948 provided out of revenue), and the outstanding debt is £96,503, less £22,0[illegible]3 in sinking funds.

Revenue was £27,136 (compared with £26,709 in previous year) and total costs were £21,909 (£20,053), leaving gross profit £5,227 (£6,656). Sinking fund and repayment of loans required £5,830 (£5,705) and interest and special charges £4,934 (£4,375), the net result being a deficit of £5,537 (£3,424). Fuel cost £12,229 (£10,574) = 0·72d. (0·61d.) per unit sold, and total operating costs were equal to 1·29d. (1·16d.). Units generated were 4,518,260 (4,566,333) and sold 4,063,721 (4,162,750). Maximum load on feeders was 1,938 (1,890) kw., and load factor 26·6 (27·6) per cent.

The gross capital outlay on the tramways is £196,682 (no increase), of which £114,751, less £9,523 in sinking fund, is outstanding. Revenue was £65,021 (£66,884) and operating costs were £57,208 (£53,485), leaving gross profit £7,813 (£13,399). Interest required £4,788 (£4,905) and sinking fund and repayment of loans £6,238 (£6,542), and the net deficit was £3,213 (£1,952). Operating costs were 8·83d. (7·89d.) per car-mile, and revenue was 10·04d. (9·87d.). Passengers carried were 18,618,754 (20,427,941), car-miles run 1,554,164 (1,626,104), and units used 2,392,108 (2,437,216).

Edinburgh. The electric lighting accounts for the year ended May 15 show gross capital expenditure £1,195,858 (increase £29,204), of which £640,162 has been redeemed.

Revenue was £142,611, working and general expenses were £83,361, and gross profit was £59,250. Interest required £18,182, [illegible] £38,349, [illegible] £2,7[illegible]. Units generated were 22,478,401 (compared with 21,264,313 in previous year), and sold 17,997,251 (17,373,681), of which 9,030,990 (7,216,530) were for power.

Huddersfield. The accounts of the tramways undertaking for the year ended March 31 show gross capital expenditure £477,707, and the total amount of the sinking fund is £166,675.

[illegible]

Newcastle-under-Lyme. [illegible]

[illegible]

Wakefield. [illegible] year ended March 31 show total capital expenditure [illegible]

[illegible]

COMPANIES' MEETINGS AND REPORTS.

Dick, Kerr & Co. Ltd.

[illegible]

The CHAIRMAN [illegible] present the annual report and balance-sheet, whereby it will be seen by comparing the balance-sheet with last year's figures the net profit shows an appreciable increase. The figures taken in conjunction with the totals of assets and liabilities shown indicate the magnitude of the com[illegible] circumstances we are unable to publish details. The total of the assets shown in the balance-sheet is £2,193,688, compared with £1,753,410 last year, the increase being chiefly made up by the difference in the item sundry investments, also increases in the items of stock-on-hand and work in progress, contract balances and sundry debtors. The latter items are, of course, always liable to fluctuation from year to year. With regard to the increase in the figure of investments, this is the result of the acquisition of the shares in the United Electric Car Co. (Ltd.). You will observe the capital expenditure at the works shows a decrease on last year's figure, due to our policy of writing off what we consider ample depreciation against this item, a policy which we are sure has your full approval, all the more so since nobody can forecast what post-war conditions will be in the business world, and it therefore seems essential to avoid the least possibility of inflation of our capital assets. The liabilities side shows one particularly important variation from last year's figures, namely, the increase under the heading of creditors and estimated liabilities. This figure is £953,596, a large advance upon last year, although the increase is, of course, set off by the increases on the asset side of the balance-sheet already mentioned. The reason for this increase in the figure of creditors is that it includes the reserve we have set aside for the excess profits duty, as although our liability under this heading has not yet been definitely settled, it is very obviously necessary for us to reserve what we consider a sufficient sum to meet this charge.

The Government continues to be our principal customer, with continuously increasing demands both in quantity and variety, and I wish I were allowed to tell you in detail of the ramifications of manufacture and construction which have been undertaken and successfully completed by your organisation; and still more would I like to tell you of what is being done now and about to be done in the immediate future. Suffice it to say that all the departments for which we are working, both at the Admiralty and the Ministry of Munitions, show their appreciation and [illegible] work to the limit of our capabilities. As mentioned in the report, the national factory erected under our auspices has been handed over to the Government, and we have now in hand the erection of two more factories for another purpose, and these, together with the [illegible] important works in different parts of the country [illegible] occupied for some time, keep the contracting department very busy, and your staff of trained engineers fully occupied.

[illegible]

I now come to the [illegible] the United Electric Car Co. [illegible] [illegible] are satisfied that after the war there will be no difficulty in keeping them [illegible]

[illegible]

[illegible] employers we are naturally following the attitude of labour itself, and fully realise that to meet the necessities of after-the-war conditions a complete understanding and co-operation between capital and labour is both desirable and necessary. Your directors and your management committee have confidence that all will be well in this direction, provided labour is met in a spirit recognising that an entirely new basis of relationship must be established. Given the country and the Empire meet the new conditions that are bound to arise after the war fairly and squarely by adopting new methods of Empire and international commercial relationship, I think the internal relationship of employer and employed can safely be left to the common sense of those directly concerned. The chairman concluded by moving the adoption of the report and accounts as set out in our last issue.

Mr. R. H. PRESTWICH (Deputy Chairman) seconded the motion, and it was carried unanimously.

[illegible] Mr. T. D. LINGARD and seconded by Mr. D. C. ELLIS, the retiring directors (Mr. C. T. Cayley and Mr. R. H. Prestwich) were re-elected, and the Auditors (Messrs. Gane, Jackson, Jefferys and [illegible] re-appointed.

In moving a vote of thanks to the Chairman, the Board and especially [illegible] Mr. [illegible] the Managing Director, Mr. FOX said he congratulated the Board on their policy in amalgamating with Messrs. [illegible] the United Electric Car Co. He also congratulated them upon being, as he believed, the first industrial company in this country to admit its officials as part and parcel of the business [illegible] the Board of Management.

The motion having been seconded and carried unanimously, the CHAIRMAN announced that he did not think that at the moment the Board could hold out any prospect of an interim dividend on the ordinary shares, in consequence of the extra work it would entail for the auditors.

BARCELONA TRACTION, LIGHT & POWER CO. (LTD.) The report [illegible] Dr. F. F. Parshall has issued a report showing that [illegible] by the companies operating in Spain, [illegible]. Notwithstanding the difficulties caused [illegible] outlined in Dr. Parshall's original report have been substantially completed. The continued high price of coal necessitated a considerable change of plans, and in view of the rapid growth [illegible] for the Ebro Co. to begin the construction of another hydro-electric plant. Such financial provision has been made as will enable that company to carry on construction into 1918. Work on the new plant was begun in July last and is being rapidly pushed forward. It is hoped that when complete it will furnish sufficient power [illegible] number of years. The net revenue was \$1,875,315, against \$1,316,282, and the interest on Prior Lien "A" bonds \$331,900, against \$96,355, leaving a surplus of \$1,543,415, against [illegible]. [illegible] first six months of 1917 indicate a further large increase, and it is anticipated that this rate of increase can be maintained throughout the year. Under the plan approved by bond- [illegible] up to Jan. 1, 1918, are to be [illegible] bond interest [illegible] that on the [illegible] completed the extension of its railway to San Cugat, about nine miles north of Barcelona. In [illegible] profitable undertaking. The application for a concession for unification [illegible].

[illegible] (LTD.) [illegible]

[illegible] GORHAM (LTD.) [illegible]

[illegible] LIGHT & POWER CO. (LTD.) [illegible]

NORWICH ELECTRIC TRAMWAYS CO.—The total traffic receipts for the year ended June, 1917, were £43,718 (against £42,834 in 1916), expenditure was £30,827 (against £29,509) and net profit was £12,885 (against £13,324); with £429 brought forward (after paying the dividend, providing for reserve, &c.) the available total is £13,314. The directors recommend that £8,000 be placed to reserve fund and that £5,280 be devoted to paying 2 per cent. dividend for the year, leaving £34 to be carried forward. The number of car-miles run was 903,484 (against 932,934) and the passengers carried were 10,767,626 (10,405,881).

on the cumulative preference shares. The subsidiary companies in Venezuela and the Argentine have placed to reserves for renewal and general purposes £7,123.

NEW COMPANIES.

AERO-ACCESSORIES (LTD.) (148,667.) Private company. Reg. Oct. 13, capital £2,000 in £1 shares (500 preference). Subscribers are H. J. Golding, electrical engineer, and C. A. West, electrical engineer.

CHAPPELL, PUDNEY & CO. (LTD.) (148,685).—Private company. Reg. Oct. 17, capital £6,000 in £1 shares, to take over the business of furnishing and general ironmongers, engineers, &c., carried on by H. H. Portway, at Halstead, Essex. Permanent directors are G. M. Chappell and C. C. Pudney, electrical engineers.

LINCOLNSHIRE MOTOR & ELECTRIC TRACTION CO. (LTD.) (148,735). Private company. Reg. Oct. 24, capital £5,000 in £1 shares, objects as indicated by the title. First directors are S. A. Fuller, C. A. B. Turner and N. Green. Reg. office: 5, Wellowgate, Grimsby.

LO-THERMO PATENTS (LTD.) (148,701).—Private company. Reg. Oct. 18, capital £1,000 in £1 shares, to acquire from Electromotors (Ltd.), B. Longbottom and E. Greenhalgh the benefit of certain inventions relating to dynamo-electric machinery, and to carry on the business of electrical engineers and contractors, electric manufacturers of and dealers in railway, tramway, electric, galvanic and other apparatus, &c. First directors are W. T. Stubbs, B. Longbottom and E. Greenhalgh. Reg. office: 61, Brown-street, Manchester.

WEST BROMWICH METAL CASTINGS CO. (LTD.) (148,659). Private company. Reg. Oct. 11, capital £2,000 in £1 shares, to carry on the business of ironmasters, founderers, mechanical and electrical engineers, &c. Permanent directors, W. Lawley, jnr., J. Lawley, jnr., J. W. Gaunt and S. F. Rogers. Reg. office: Edward-street, West Bromwich.

WILSON, COPLEY & CO. (LTD.) (148,710).—Private company. Reg. Oct. 19, capital £15,000 in £1 shares, to take over the business of an ironfounder and engineer carried on at Middlesbrough as "Wilson, Copley & Co.", and the business of ship repairers, marine, electrical and general engineers, &c., carried on as the North-street works. First directors are J. W. Brown and W. H. Crosthwaite.

COMPANY REGISTERED OUTSIDE THE U.K.

SUPPLY ASSOCIATION AMONG METALLURGISTS & MACHINE MAKERS. [illegible]. Particulars filed Oct. 24, 1917. Reg. in Italy. Objects: The direct purchase of raw materials on behalf of associates in Italy and abroad, &c. Capital unlimited. Shares are of 100 lire each, nominal value. British address: 26, Portugal-street, W.C.2, where J. H. Pearson, London manager, is authorised to accept service.

CITY NOTES.

BABCOCK & WILCOX (LTD.) An interim dividend of 6 per cent. has been declared, being the same rate as in 1916.

BANK FUR ELEKTRISCHER UNTERNEHMUNGEN (ZURICH). The profit [illegible] June 30 last was fr. 4,052,819 (against fr. 6,461,7[illegible]) [illegible]. A dividend of 5 per cent. has been declared.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—An interim dividend of 7 per cent. per annum (3s. 6d. per share), less tax, has been declared on the ordinary shares for the past half-year.

The [illegible] during the four weeks ended July 27 were 2,307,315, compared with 2,020,562 in the corresponding four weeks of 1916. The [illegible] units sold to consumers during the five weeks [illegible] Aug. 31, 1917, amounted to 2,982,020, compared with 2,616,727.

CLEVELAND TRUST (LTD.) The profit for the year ended Sept. 30 [illegible] brought forward the total available is £2,021. A dividend at rate of 2½ per cent. has been declared on the ordinary [illegible] and £329 carried forward.

WEST AFRICAN TELEGRAPH CO. (LTD.) A half-yearly interim [illegible] per annum [illegible] per share has been declared tax free.

WEST INDIA & PANAMA TELEGRAPH CO. (LTD.) The directors [illegible] the following interim dividend [illegible] in respect of the year 1917 [illegible] per share [illegible] per share on the ordinary [illegible].

THE ROUND TABLE.

By "KVA."

I told a friend in the manufacturing line that we were producing a "special" on "The Handling of Materials"; he replied that he was only interested in the handling of Priority committees!

* * * *

In these days of Klaxons, electric warning signals and motor driven sirens, the following from the "Daily Chronicle" "Office Window" is of interest :—

A writer in a contemporary, dealing with raid warnings, declares that at the Judgment Day some people will fail to hear the Last Trump. The same sort of idea was more elaborately worked out at Buffalo by an American orator named Corwen, in the midst of whose speech imitating cries of "Louder, louder!" were heard. The purpose was, of course, simply to fluster the speaker and spoil the meeting. Corwen bore with it patiently for a time, then suddenly he stopped his speech proper, and according to Grant Duff, extemporised to some effect.

"At the last day" he said, "when heaven and earth shall pass away like a scroll, when the Ancient of Days shall sit on His great white throne, thousands and tens of thousands of the heavenly host ranged on his right Hand and on His left, when the Archangel blows the trump that shall rend the tombs and wake the dead, some fool from Buffalo will be heard shouting, 'Louder, louder!'"

* * * *

These air raids! A shell from an anti-aircraft gun fell in the yard of a large works, it having failed to explode. The works pride themselves on a fuse of their own design, because it had never been known to fail. On examination the shell fuse revealed the astounding fact that it was fitted with one of the firm's infallible fuses; how kind of the shell to show such discrimination!

* * * *

T. N. T.

We've sung about the Army and our Heroes "over there,"
And we've sung about our Sailor-lads at sea;
We've glorified our Flying men, the Nelsons of the air
Now we'll sing a little song of You and Me.
You and Me, You and Me
It's a dingy sort of Hero we may be
But there's this to say about us
That they can't get on without us,
While they look to us for shells and T. N. T.,
T. N. T. T. N. T.,
For their shells and fuses, guns and T. N. T.

We haven't put on Khaki, and we haven't left our homes
For a summer's picnic, tramping by the sea
We've sweated hard and stuck to work in spite of all their "combs,"
In a uniform of slops, or dungaree,
Dungaree, Dungaree,
Or a stinking, greasy over all may be,
But there's this to say about it,
That we're fighting - never doubt it!
While we're making shells and guns and T. N. T.
T. N. T. T. N. T.
Turning shells and loading tons of T. N. T.

And if you think we're slackers, or afraid to risk our lives,
You should come and work a shift or so in [illegible],
Just come and take a lesson from your daughters and your wives
As they do their little bit along [illegible]
They and we, They and we,
Never [illegible] about what [illegible]
But there's this to say about it
We've no time to run and shout [illegible]
When there's trouble in the [illegible] with T. N. T.
T. N. T. T. N. T.
And there *can* be trouble where there's T. N. T.

A. [illegible]

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN, October 30, 1880.]

JARROW.—A [illegible] market shall be lighted by means of the electric light.

ELECTRIC LIGHT AT [illegible].—The [illegible] Brewery Co. propose to adopt the electric light as a means of illuminating some parts of their extensive premises.

THE ELECTRIC LIGHT IN COLLIERIES.—Mr. W. H. [illegible], in a letter to "The Times" of Oct. 28, fully corroborates our recent remarks [illegible] and adduces the same reasons as we did against the use of electricity in fiery mines.

BALLOONING AND THE ELECTRIC LIGHT.—Arrangements have been made by the Balloon Society of Great Britain for having the English and French balloons on view at the Royal Aquarium, Westminster, and, further, delivery there of a series of lectures in connection with ballooning and the lighting of large surfaces by means of the electric light.

PROFESSOR GRAHAM BELL.—"La Nature," [illegible] an interview one of its contributors has had with the illustrious inventor, is warm in its praises of his conscientious and indefatigable industry. The amount of calculation and painstaking labour bestowed upon the photophone, the written evidence of which was inspected by the interviewer is, says "La Nature," quite astounding.

Electric Incandescent Lamps for Street Lighting.—As showing the extent to which electric incandescent lamps (particularly the new half-watt type) are being used for street lighting, and replacing arc-lamps, the returns from the United States for the year 1916 show an eight-fold increased application over the number of lamps in similar use in 1913.

Protective Lighting.—[illegible] flood lighting projectors, fitted with half-watt lamps [illegible] United States and Canada, for the protection of industrial plants and factories, shipyards, docks, bridges [illegible], power plants [illegible] located in open areas, railway termini and yards, camps, prisons, &c. From the number of escapes this year of German prisoners from English prison camps it would appear that flood lighting with electric incandescent lamps in floodlight projectors would serve a useful purpose in assisting the guards to watch over prisoners and prevent such escapes. These floodlight projectors can be made to give all varieties of light distribution, from the long projective ray to a broad angle distribution [illegible] wide area [illegible] as well as narrow [illegible] can be [illegible] and illuminated as brightly as by day.

Standardisation of Voltages for Electric Lighting.—Reports from Canadian and the United States Lamp Manufacturers [illegible] progress is being made in the standardisation of lamp voltages. The chief voltage range [illegible] Canada and the United States is 100-130 volts, and [illegible] the voltages standardised are 110, 115 and 120.

[illegible]

Spanish Iron and Steel Products.—[illegible]

[illegible]

LEEDS ELECTRICITY WORKS EXTENSIONS.

(Continued from page 165.)

Monopoly of Supply.

The possession of a monopoly such as that of electricity supply, the nature of which is a matter of supreme importance to a great number of the inhabitants of the City, and directly connected with its prosperity, carries with it very great obligations, one of which is the provision of adequate machinery to meet such demands as are likely to arise. The difficulty of deciding upon a date for commencing further extensions has been increased by the larger sizes of units which can now be purchased economically, of a reliable character and justified by what appears to be the prospect of very large growth. The purchase and installation of these large units makes it necessary to form estimates of demand much further ahead than was the case when smaller plants were required, and in our own case, where we have not only to purchase the machinery, but to erect the buildings to contain it, this period of time is necessarily lengthened. In attempting to arrive at an estimate of what the demand will be some few years ahead the Committee will appreciate that it is not at all a question of the minimum demand that may arise, but rather of estimating as far as possible what would be a reasonable demand to anticipate, and providing plant to meet that, leaving a sufficient margin of spare to deal with any extraordinary increase. The success of an electricity undertaking is not altogether indicated by the surplus profit which it is enabled to present from time to time, but also by the assistance it gives in maintaining and increasing the prosperity of the local industries. After referring to the Board of Trade Electric Power Supply Committee and to its preliminary conclusions, &c., Mr. Hefford states that in providing for considerable growth, the Electricity Committee will have behind them the moral support of the views already expressed by the Board of Trade Committee.

The older portion of the works contains at present generating machinery amounting to 26,600 kw., the boiler-house having a steaming capacity of 21,000 kw., derived from 12 boilers of 750 kw. and 12 boilers of 1,000 kw. capacity on a basis of 22 lb. of steam per kilowatt-hour. The portion of the new works now completed will contain 18,000 kw. of generating machinery and 12,800 kw. of boiler plant (derived from eight boilers of 1 600 kw. capacity on a basis of 18 lb. per kilowatt-hour), but it will be recollected that the 6,000 kw. British Thomson-Houston plant has been installed as a safeguard in the event of further breakdowns occurring with the older machinery. It will be seen, therefore, that the total amount of plant installed at the end of this year will be 44,600 kw. of generating machinery, and 33,800 kw. of steam raising machinery. Allowing for a reasonable margin of spare plant the maximum load that should be dealt with in the engine-rooms would be 29,800 kw. it being assumed that providing all the plant was in a satisfactory condition the following machinery would not be actually generating electricity at the time of maximum load:—One 6,000 kw. B.T. H. plant, two 3,000 kw. Willans-Dick Kerr and two 1,400 kw. reciprocating engine plants, a total of 14,800 kw. spare or uneconomical machinery. During the winter of 1916-17 a maximum load of 22,255 kw. was recorded, but owing to steaming difficulties a certain amount of restriction was in force and it must be remembered that a very considerable effect on the maximum load would be brought about by the reduction of public and private lighting. It is difficult to arrive at a figure for the purpose of calculating the demand to be anticipated during the next three years.

Anticipated Demand.

The last recorded maximum load upon which calculations must be based possibly includes a small demand directly brought about by the war and which may cease on the conclusion of hostilities, but at the same time the restrictions in force with regard to lighting, and also to potential users for both power and lighting, must be considered, and it is quite conceivable that the restrictions will more than counterbalance any [illegible] which has been met, so that for the purpose of [illegible] it would appear to be reasonably safe to accept the figure of 22,255 kw., as representing a normal condition of load for the winter of 1916-17. With reference to the figure which is to be taken as representing [illegible] normal growth subsequent to this date, it must be [illegible] that a large amount of domestic load is available which is [illegible] restrictions are removed. A considerable number of applications for such supply have had to be refused by the department [illegible] deferred, and a similar condition [illegible] to certain power applications. Very great progress has been made in the design of domestic appliances requiring [illegible] and there is little doubt that a very great [illegible] from this source, as during the war [illegible] has been almost unobtainable. The enforced use [illegible] purposes during the war has convinced [illegible] of the wisdom of adopting the Corporation supply [illegible] considered the impetus which will be [illegible] industry by the conclusions of the Board of Trade Committee. Two methods of forming an estimate of the [illegible] are available. One is to base the [illegible] occurring during years which [illegible] and the other to base it upon the average annual increase. In 1916-17 the [illegible] was 33 per cent., but in 1915-16 there was [illegible] 14 per cent., owing to the lighting restrictions and [illegible] a certain amount of traction load which had previously been supplied by the electricity department was removed to the [illegible] Power Generating Station. Between the years 1911 to 1914 the increase [illegible] 74 per cent., whereas from 1914 to 1917 the increase was [illegible] 60 per cent. Assuming that between

1917 and 1920 the load increased 60 per cent., or by 13,353 kw., the maximum demand for the year ending March, 1920, would be 35,608 kw. By the second method of computation the load for the winter of 1913-14 was 13,880 kw., whereas that for the winter of 1917-18 it is estimated at 28,000 kw., giving an average annual increase during the four years of 3,500 kw. The figure of 28,000 kw. would show an increase over the preceding winter of 5,745 kw., but it is explained by including a certain amount of load which could not be carried during the maximum load period of 1916-17, owing to steaming difficulties and also that something like 800 kw. street lighting load was quite out of use. Mr. Hefford thinks it imprudent to conclude that the average increase of load during the next few years will be less than 3,500 kw. per annum, and on this assumption the maximum demand will be 31,500 kw. in 1918-19 and 42,000 kw. in 1921-22. The amount of additional generating plant proposed to be installed in the new works is 24,000 kw., it being the intention to install larger units of boiler plant in the second portion of the boiler-house than will be installed in the first portion. The generating plant in the old works would be 26,600 kw. and in the new works 42,000 kw., or a total installed of 68,600 kw., with spare plant of 20,800 kw., giving a total available of 47,800 kw. The boiler plant in old works would be 21,000 kw. and in new works 30,400 kw., giving a total installed of 51,400 kw.; the spare plant would be 6,300 kw., leaving a total available of 45,100 kw. It will, therefore, be possible to deal with a maximum demand of 47,800 kw. in engine-rooms and 45,100 kw. in boiler-houses when the new works are completed. It would appear that the full ultimate capacity of the Whitehall-road works will be required to meet the demand of the winter 1920-21. An examination of tables (given in the report) of the engine-room and boiler plant, assuming that the estimates of the growth in demand are realised, indicates that the undertaking will pass through a critical period until such time as the works are completed and to meet the demands arising may imply the use of the "spare" plant to a very undesirable extent. In arriving at the tables it is assumed that by proceeding with the extensions at once four additional boilers can be installed ready for use for the winter of 1919-1920 and also an additional 12,000 kw. turbo-alternator, the second generator and the remaining four boilers being installed a year later. Owing to the delay in completion of the present extension the consideration of this further extension has been unduly deferred and the amount of time in which it will have to be carried out is only barely sufficient. The carrying out of the proposed programme would appear to make the supply so far as the engine-room plant is concerned as safe as reasonable anticipation can foresee. The capacity of the plant in the engine-room will then be considerably in excess of the capacity of the boiler-houses, but this should invariably be the case. It would appear desirable that the work should be commenced very early in 1918, and to enable this to be done plans should be at once made, together with an application made to the L. G. Board for sanction to raise the necessary capital, and such part of the work proceeded with as the Ministry of Munitions will allow. Owing to the largely increased cost of materials, labour, &c., which has occurred during the war, the estimate for the complete scheme presented in 1914 requires considerable modification. A new estimate is, therefore, presented to indicate the anticipated cost of completing the works as follows:—

Boiler-House, &c.—Extension of boiler-house £35,000, extension of overhead bunkers £4,500, eight water-tube boilers £41,000, mechanical stokers and driving gear for eight boilers £11,500, eight fuel economisers £8,500, four induced draught plants £5,200, four steel chimneys £6,000, extension of coal and ash handling plant £9,000 and boiler and economiser foundations, flues and seatings £15,000.

Engine-House, Switch-House, &c.—Extension of engine and switch-house £78,000, two 12,000-kw. turbo-alternators and auxiliary plant £100,000, two 12,000-kw. condensing plants £70,000, switch-gear, reactances, interconnecting and generator cable work £55,000, foundations for two 12,000-kw. generating plants and auxiliaries £3,000, lift for switch-house £1,000 and flooring round generating plant £2,000.

Circulating Pump-House.—Extension of circulating pump-house £13,700, steam turbine-driven pump (complete) £5,000, condensing plant for turbo-pump £1,500, circulating pump for attaching to existing engine £1,500 and foundations for plant £1,000.

Sundries.—Additional steam feed, circulating water and other pipes £16,000, feed pumps, hotwell, screens and tanks £1,500, extension of concrete tank and ducts in wharf £5,600, construction of new road, &c., £6,000, small motors, cables and general wiring, power and light £5,000; extension of office buildings, &c., £14,000. Making a total of £515,500, or allowing for extra and contingencies (10 per cent. on £177,800 for buildings, &c., and 2½ per cent. on £337,700 for machinery) £541,722.

Plans and curves are attached to the report indicating the general arrangement of the works, together with the proposed extensions, the curves illustrating the growth of the business to date and the effect of such growth upon the cost of generating and distributing electricity to consumers. Mr. Hefford also suggests the replacing of four 1,400 kw. reciprocating plants by two turbine-driven alternators and their necessary auxiliaries, each of 6,000 kw. capacity. It is anticipated that not only would the installation of these plants effectively increase the generating capacity of the works and so possibly postpone the construction of new works on a new site, but that considerable economy would result from their adoption. The removal of the four 1,400 kw. plants would liberate space that would readily accommodate two 6,000 kw. units. The steam consumption of the 7,500 kw. sets is found to be 14·6 lb. per kilowatt-hour, whilst that of the plant proposed to be installed will be 13·6 lb. per kilowatt-hour. It can be accepted that the more economical plant would be run as frequently as possible and assuming 3,000 hours use of the new plant at a load of 5,000 kw. the actual steam saving amounts to

15,000,000 lb. per annum. The coal used by the department will evaporate 7 lb. of water per lb. to the temperature and pressure required, and the actual tonnage of coal saved annually will be 956 tons, or £478 with coal at 10s. per ton. Further the use of the plant as indicated will liberate one of the 7,500 kw. sets to take any load that would otherwise be carried by the 3.000 kw. plants, and the 1,400 kw. plants, which can be safely assumed to amount to 6,000 kw. for 500 hours. The steam consumption of these smaller plants (which are practically obsolete) averages 24 lb. per kilowatt-hour, and the annual saving would be £900. In addition to those direct savings there would be a direct gain in steam-raising plant and also space for installing an additional 6,000 kw. generator. The actual amount of new plant that could be steamed by the boiler plant that would be required for the old machinery is 9,882 kw., or an actual gain in the generating capacity of 4,282 kw. so far as steaming conditions are concerned, the actual increase in installed capacity of engine-room plant being 6,400 kw. To provide at modern prices boiler plant, coal and ash handling plant, buildings, land, &c., would cost at least £5 per kilowatt, so that a capital saving on this account is effected amounting to £21,410, which, at 10 per cent. (the present time equivalent of interest and sinking fund charges), requires an annual payment of £2,141. The estimated cost of one 6,000 kw. turbo-alternator and condensing plant is £30,000, and with foundations £750, additional pipework (£1,000), switchgear and cables (£1,000) and sundries £2,500, the total would be £35,000.

The capital sum outstanding at March 31, 1918, on account of the 1,400 kw. plants will be approximately £34,000 and this amount, less scrap value of the discarded plant, which is estimated to be £6,000, would have to be paid into the sinking fund out of revenue in order that a loan might be obtained to purchase the new machinery. The proposal then is to utilise surplus profits and reserve fund (which would otherwise be invested outside the business) in paying off the outstanding debt (£34,000) on four 1,400 kw. sets of plant, and then to borrow £35,000 for the provision of a 6,000 kw. set in replacement thereof. In the ordinary course this outstanding debt would be repaid by annual instalments, the repayment being completed on March 31, 1927. The amount to be provided from revenue or reserve would be £28,000. The interest and redemption fund charges on the amount to be borrowed for the new plant (£35,000), with an assumed life of 15 years, would work out at about 10 per cent. per annum, involving an annual charge of £3,500, less interest and redemption discontinued on discarded plant (£34,000 at 7 per cent.), £2,380, leaving a net increase in annual capital charges of £1,120. The annual gain or saving by the replacement of the old plant would be £3,519, that is in coal £1,378 and gain in boiler capacity, &c., equal to a capital value of £21,410 (interest and redemption fund at 10 per cent.), £2,141. The investment of £28,000 would, therefore, produce a net return during an estimated period of eight years of £2,399 per annum, which is at the rate of 8½ per cent. per annum. The annual income from the investment will thus be approximately £1,000 more than would be obtained by investing the surplus profit and reserve fund outside the business. The installation of this plant during the coming year, followed by that of a similar set a year later is strongly recommended to the Committee, as it would have the effect of completely equipping the works with turbine-driven machinery, and would increase the capacity of the generating station during the period in which the larger extensions were being carried out, as the department should have the assistance of one of the plants for the winter of 1918-19, and of both plants for the winter of 1919-20. On the assumption that the report will be adopted amended tables of engine and boiler-house plant, &c., are added, and, in addition a third table is added indicating for the years under consideration the total available capacity of plant, the anticipated maximum demand and the surplus or shortage. There are also estimates of income and expenditure, &c. The capital expended at March 31 last was £1,662,989, and the further additions and extensions of plant and mains will cost £1,178,000, and the capital charges on these sums will amount to £201,002; the working costs (including £20,000 for capital expenditure) are estimated at £373,202, and the total revenue [illegible] (including £274,[illegible]84 from power and heating (at 0·76d. per unit). The available balance is put at £43,670, and this could be used for reducing the price, [illegible] reserve fund, &c. Estimates are also given of revenue, capital charges, &c., on the partial completion of the new works.

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CONTENTS.

NOTES.

Co-operation of Electricity and Gas Undertakings.

In the report of the National Gas Council, covering their work during the past four months, we notice a reference to co-operation between electricity and gas undertakings. In fact, the Council has gone so far as to appoint a sub-committee which has been considering the question of such co-operation. The co-operation in question, however, is not that which has been discussed in the electrical press from time to time, namely, the working of electricity departments and gas departments under a single management, or of an electricity undertaking and a gas undertaking being operated by a single company. It has generally been agreed that co-operative working of this kind may be distinctly advantageous in the case of small undertakings and scattered areas, but it is more than doubtful whether anything would be gained by running large undertakings on these lines. In all probability the rivalry and competition which is so desirable within proper limits for healthy progress would not be so evident under such conditions.

Co-operation in Fuel.

The co-operation, however, which the National Gas Council has in mind is of a different order. A report is in course of preparation which it is proposed to submit to the Government, and which appears to contain two main suggestions. The first of these is that in the interests of national economy it is desirable that all coal [illegible] should be first treated [illegible]. There will, we think, be [illegible] the desirability of adopting this course. [illegible] however, is not so readily [illegible] that gas undertakings in proximity to electric power stations should endeavour to arrange with the electrical undertakings for the supply of fuel for steam raising in the form of coke or coke breeze. Up to [illegible] made in the use of [illegible] a feeling that it is an unsuitable fuel for steam raising, provided suitable grates are used for the purpose. On the other hand, if a serious amount of coke is to be used in this way it is probable that a surplus of gas would result. To sell gas for the purpose of lighting [illegible] but the selling of gas on a purely thermal basis to compete with coal is quite another, and it may well be that a gas undertaking would be unwilling to sell such gas at a price [illegible] responsible for the electric power station. Be this as it may, it is certainly desirable to foster co-operative working of this kind.

Abolition of Leaving-Certificates.

We fear there is one effect of the abolition of "leaving-certificates" which has not been sufficiently realised. We refer to the effect upon wages. So long as leaving-certificates were in force there was little inducement for any particular firm to raise their wages merely from the point of view of obtaining labour. Now, however, that leaving-certificates have been abolished there will naturally be a certain movement of labour, and this will be attracted to those works where the higher wages are paid. Consequently such works as are able to pay higher wages will probably do so if they are in need of labour, and will be at an advantage. We notice, for example, according to remarks by the chairman, Mr. H. E. Jones, at the recent meeting of the National Gas Council, that the Government itself is [illegible] quite beyond what they could hope to pay in undertakings having to face a body of [illegible]. Here we see one of the disadvantages of Government undertakings. The payment of higher wages than the recognised rate is a matter of no importance to the Government, because any increase merely comes from the pocket of the taxpayer. It is otherwise, however, with industrial undertakings, and the position becomes [illegible] which are not in a position to pay higher wages, owing to a diminishing margin of profit.

The Testing of Dyes and Pigments

In view of the rapid development of the [illegible] dye industry [illegible] recent contribution by Mr. M. L[illegible] [illegible]

materials. Mr. LUCKIESH appears to regard the spectrophotometer as the most scientific device available for the comparison of colour values. By its aid relatively small variations in different regions of the spectrum can be observed. It is found, for example, that the colour of surfaces depends considerably on the nature of the fabric and on the fineness of the crystals of the pigment applied. Such conditions affect the [illegible]nt to which the coloured surface is penetrated by the light [illegible]nd hence, also, the coloration of the reflected light. [illegible]strated by microphotographs of cotton and silk fabri[illegible]tter producing appreciably stronger colouration. The spe[illegible]meter can also be readily applied to the study of coloure[illegible]s. It is interesting to note that there is no known d[illegible] will give pure yellow transmitted light, though a fairly [illegible] in the spectrum can be obtained by the combination o[illegible] In any case, the concentration and depth of solutions [illegible] be carefully specified, as the emergent light is natural[illegible] by the degree of selective absorption of certain colou[illegible]

Comparative Costs of Prime Movers

THE Paper by Mr. OSWALD WANS, which we [illegible]tract on another page, gives a useful comparison of th[illegible]g costs of the principal prime movers. As Mr. WANS rema[illegible] parisons are too often made on the airy assumption th[illegible] can be based simply on the economy of fuel. Althoug[illegible] is undoubtedly of great importance it is by no means the [illegible] point to be taken into consideration. Capital charges and ot[illegible] running costs play an important part. We are also glad [illegible] see that Mr. WANS has taken into account the very important differences that may be found in the maximum overload that a particular type of engine is capable of carrying. As Mr. WANS has only taken the comparison up to a horse-power of 500 he is able to embrace all the usual prime movers, from the steam engine up to the Diesel engine, and it is interesting to find that on his assumptions, in the case of plant for 250 B.H.P., the fuel for the steam engine must be as low as 14s. per ton to compare with the price of 60s. per ton for oil fuel for Diesel engines. Of course, if the comparison is carried very much further we reach an entirely different state of affairs. The steam turbine then takes the place of the reciprocating engine, and we soon reach a point at which all other types of prime movers must be put on one side for one reason or another.

Royal Institution. A general meeting of the members of the Royal Institution was held yesterday afternoon (the 5th inst.), Sir James Crichton-Browne, F.R.S., treasurer, in the chair. The special thanks of the members were returned to a lady member for an anonymous gift of £500, and to Mr. Richard Pearce for his donation of £100 to the fund for the Promotion of Experimental Research at Low Temperature.

Royal Society. The following is a list of those who have [illegible] by the president and council of the Royal Society [illegible] the council at the anniversary [illegible]

[illegible]

Federation of British Industries. [illegible]

[illegible]

whose joint capital represents over 2,000 millions sterling, and who employ some 3,000,000 workpeople, to stand unreservedly behind the British and Allied Governments in furnishing to Italy any support which they may deem necessary.

The Qualities of Ferro-chromium.—In the "Iron and Steel Age," an account is given of work on ferro-chromium products. During recent years the use of chromium in steel has largely increased, especially in the manufacture of armour plate and armour-piercing materials. In conjunction with nickel it yields the well-known chrome-nickel steel, and it is now being used, together with tungsten, for magnets. Modern ferro-chromium is a high percentage alloy containing 60 per cent. of chromium or more, and its manufacture has been greatly expedited by the development of the electric furnace.

The Future of the British X-Ray Industry.—In the last issue of the "Journal" of the Röntgen Society, Dr. Robert Knox makes a contribution to the discussion which has been proceeding on the future of the British X-ray industry. Among the steps which he proposes are: (*a*) The formation of an advisory committee, consisting of physicists, technical experts and medical men, to act in collaboration with the British Electrical and Allied Manufacturers' Association. (*b*) Fuller co-operation between existing firms, even to the extent of amalgamation. (*c*) The equipment of an institute or a number of institutes throughout the country as teaching centres, in collaboration with radiologists. (*d*) Better facilities for research and experimental work, carried out in conjunction with physicists and medical men. (*e*) The establishment of research scholarships in technical work, and, later, travelling scholarships for gifted students. (*f*) Scientific training of assistants in technical subjects.

Electric Heating and the Unloading of Oil.—The "Electrical World" mentions an interesting application of electric [illegible] namely, in connection with tanks of oil and other fluids, which in cold weather become very thick and [illegible] making unloading quite a tedious process. If tank fluids are provided with electric heating, the speed of de[illegible] be very materially increased, and the economic value o[illegible]ng in time of unloading more than compensates for the c[illegible]uipment and electrical supply. An instance is quoted [illegible]w. immersion-type heater, which enabled a tank car t[illegible]tied in three hours instead of three days. In view of t[illegible]pated shortage of coal during the winter, and the vita[illegible]y of increasing the trackage facilities, the use of ele[illegible]ting during the coming winter will be specially oppo[illegible] Besides the oil products most widely required in com[illegible]re are many other materials to which heating could b[illegible]bly applied, notably in the coconut oil industry and [illegible] materials as molasses, which very readily thicken u[illegible]nfluence of cold.

An "Average E[illegible] Colour Photometry.—A scientific Paper recently issu[illegible] Bureau of Standards, Washington (No. 299), discusses [illegible]ns between measurements made respectively with "[illegible] and "equality of brightness" photometers. The co[illegible] of lights of different colours is supposed to be based [illegible]erage normal eye." This Paper records an attempt to [illegible]ate the results of such an eye and typical colour diffe[illegible] using a large number of observ[illegible] In particular, res[illegible]ned by a flicker photometer and by an equality of b[illegible] photometer, with different [illegible] colour difference [illegible]mpared. In terms of the Ives-Kingsbury test solutions, [illegible] the proposed normal ratio of transmissions (with a [illegible] per candle carbon lamp) is [illegible] the average of [illegible] gives a ratio of 0.99. By [illegible] obtained on the flicker photometer by a small numb[illegible] observers can be corrected so as [illegible] normal value w[illegible] degree of accuracy. On the [illegible] equality of b[illegible] measurements also vary in [illegible] to the [illegible] certain variations often over[illegible] [illegible] For sources having [illegible] high [illegible] the blue, flicker values tend to fall below those obtain[illegible] usual standard photometers; but the difference is [illegible]able in magnitude with the uncertainty of the [illegible]

The Specific Resistance of Thin Metals.—The conditions [illegible]ermining the resistance of thin films have been recently [illegible]died by several investigators. The theory of the subject [illegible] been discussed by Mr. R. W. King in the "Physical [Re]view," and some measurements on gold, silver and platinum [ha]ve likewise been made by B. Pogany (Ann. d. Physik.). [Th]is investigator points out that for such thin films there is a [cri]tical thickness below which the specific resistance suddenly [an]d rapidly increases; while for greater thickness a constant [val]ue, practically identical with that of the metal in mass, [is s]oon reached. The change that occurs is represented by [the] following relation:

$$r = r_0(1 + a/D).$$

[Wh]ere r = specific resistance of metal of thickness D,

r_0 = specific resistance of metal in bulk,

a = a constant.

[Th]e graph connecting specific resistance and thickness is [ap]proximately a hyperbola, with a very sharp turn in the [cur]ve at the critical thickness.

Double Membrane Telephone.—In the "Annales des [Po]stes, Télégraphes et Téléphones," an account is given of an [int]eresting form of telephone receiver for which several [ad]vantages are claimed. It consists of a vessel furnished at [the] base with a membrane facing an electromagnet, as in an [ord]inary receiver. But above this membrane is placed a [ho]llow cone, the base of which contains a second membrane, [pa]rallel to and a few millimetres away from the first. The [co]ne contains a second electromagnet in series with the [fir]st one, both being traversed by the speaking current. As [a r]esult the hearing value is stated to be doubled. Moreover, [the] second membrane only covers about two-thirds of the first, [an]d the annular space thus presented between the membranes [an]d the ear has a favourable effect on the conduction of sound [to] the ear, tending to suppress inconvenient crackling effects [an]d resonance. In addition, the condenser-effect of the tele[ph]one, which is generally regarded as the chief cause of resonance [tro]ubles, is considerably diminished by this new device. Ac[cor]ding to the patent the method is also applicable to micro[ph]ones.

Cooling Underground Cables.—During the summer a central [sta]tion in the middle west of the United States tried a number [of] experiments with a view to diminishing the temperature of [un]derground lead-covered cables. Some of the devices are [de]scribed in the "Electrical World." The first experiment [wh]ich consisted in placing ice in the manholes was a failure. [Ea]ch day for three successive days 200 lb. of ice was placed in [ea]ch of three manholes, but the temperature was practically [un]affected, and the same result followed when the quantity of [ice] was doubled. A large blower fan was then placed in the [mi]ddle manhole and connected to a tile sewer [illegible] which [ex]tended a distance of about [illegible] ft. to the inlet of the street [illegible]. The fan was kept running 24 hours a day, delivering [ab]out 400 cubic ft. of air per minute, but the recording thermo[me]ter did not show an appreciable fall of temperature at the [ma]nhole. Finally water cooling was [illegible]. A [illegible] at 52° F. [illegible] at the rate of 1 gallon per minute was [ap]plied. It was then found that the temperature at the [illegible] end, which was [illegible] F. [illegible] [illegible] the most successful of those tried, [illegible] [co]nditions prevented the continuation of the experiment.

The Use of Dark Glasses in Photometry.—[illegible] the above subject by Dr. H. Krüss appears in a recent issue of the "Zeitschrift für Instrumentenkunde." [illegible] [illegible] methods of diminishing the [illegible] light [illegible] the use of a rotating sector [illegible] [illegible]

opaque lines are ruled at regular intervals. It has been found that if not less than 100 lines are ruled per inch the shadows produced on the photometric field are inappreciable, especially if the source of light occupies a fairly large luminous area. Ives has also experimented with a couple of such glasses, the capacity of which can be varied by rotating them with respect to one another. Krüss now describes a somewhat different arrangement, namely, the mounting of two such glasses, one in front of the other, with the lines parallel and capable of transverse movement by means of a micrometer screw. The laterial displacement is then a measure of the absorbing value of the pair of glasses, and should be practically independent of the colour of the light. The glasses can be conveniently attached to a Lummer-Brodhun photometer, and it is stated that no inconvenience is experienced through shadows in the field of view.

OBITUARY.

Mr. Wilson Noble.—The death is announced of Mr. Wilson Noble, at one time M.P. for Hastings. He took a keen interest in science, more particularly in electricity, and for a time he was president of the Röntgen Society.

Deaths on Active Service.—The following deaths are reported:—

Lieut. F. B. Best (R.F.C.), who was reported missing on July 29, and is now reported killed, was a director of Messrs. Best & Lloyd.

Second Lieut. H. G. Savage (K.R.R.), who has been killed, was formerly in the service of the National Telephone Co., and later was assistant superintendent of the Post Office Engineering Department at Hill-street, Birmingham.

PERSONAL.

Mr. Howard Foulds, secretary of the Birmingham Corporation electricity department, has tendered his resignation in order to accept a position with an important group of electrical companies in London. Mr. Foulds will take up his new position at the beginning of the new year.

Sir Richard Vassar Smith, chairman of Lloyds Bank, has been elected president of the Federation of British Industries for the forthcoming year in succession to Mr. F. Dudley Docker, C.B.

War Honours.—The following honours have been conferred:—

Acting Sergt.-Major G. Stamp [illegible] (R.E.), formerly [illegible] assistant electrical superintendent of the North Eastern Railway Co., has been awarded the Military Cross.

Gnr. E. Hopkins (R.F.A.), formerly a [illegible] tramways employee, has been awarded the Military Medal.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, Nov. 9th (to day)

[illegible]

5 p.m. At the [illegible] [illegible], S.W. [illegible] [illegible]

[illegible]

MONDAY, Nov. 12th.

[illegible]

TUESDAY, Nov. 13th.

[illegible]

WEDNESDAY, Nov. 14th.

[illegible]

FRIDAY, Nov. 16th.

[illegible]

A COMPARISON OF THE WORKING COSTS OF THE PRINCIPAL PRIME MOVERS.*

BY OSWALD WANS.

Summary.—The author compares in detail the working costs of the steam-engine, gas-engine, oil-engine and Diesel engine for powers up to 500 B.H.P. and shows for what prices of fuel they are on an equality.

Working costs based mainly upon a low rate of fuel consumption are practically useless, as high thermal efficiency does not necessarily establish commercial superiority. The object of this Paper is to give data that will be of service in estimating capital expenditures and working costs, and in establishing the relative commercial value of the principal prime movers up to 500 B.H.P. For this purpose typical examples of the following prime movers will be considered :—

- Suction gas-engines and plants burning anthracite, coke and wood refuse ;
- Gas-engines using town-gas ;
- Oil-engines of the solid injection high-compression type ;
- Diesel engines ;
- Steam-engines.

The items constituting the total working cost are :—(1) Capital charges, *i.e.*, depreciation, insurance and interest upon capital expenditure ; (2) running charges, *i.e.*, cost of fuel, lubricating oil, water supply, sundry stores, labour and repairs. Rent and taxes are not included.

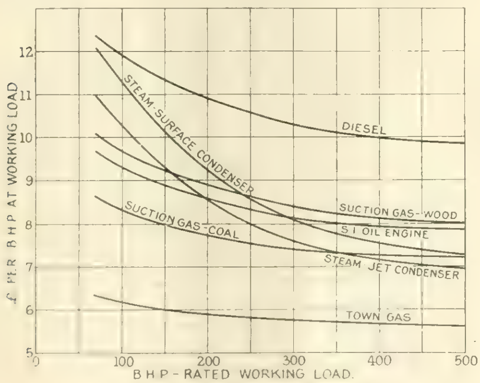


Fig. 1. Expenditure Curves.

Capital Expenditure. The capital expenditure should cover the cost of the completed installation in working order. The author includes all items except buildings and floorings and arrives at the curves in Fig. 1. Cooling towers have been included in all cases, with the exception of the smaller gas- and oil-engines of about 50 B.H.P., as the more usual practice is to employ cooling-tanks suitable for thermo-syphon circulation.

When deciding the size of the engine, it is necessary to consider its overload capacity, for this factor greatly affects the capital expenditure, the [illegible] and the fuel economy. It may be remarked in passing that [illegible] of the trouble at times experienced with internal combustion engines is solely due to excessive overloading. That gas- and oil-engines should have a large power margin is an essential of [illegible] and cannot be too strongly emphasised. The effect of the overload capacity upon the economy of an installation is dealt with later, and for the present [illegible] influence upon the capital expenditure will be [illegible]. The maximum overload that may be expected upon [illegible] considerably with the type of engine, thus:—

[illegible]	35 per cent. above rated working-load.
[illegible] oil-engine	1[illegible] ,, ,, ,, ,,
Diesel engine	1[illegible] ,, ,, ,, ,,
[illegible]	10 ,, ,, ,, ,,

The expenditure curves, Fig. 1, give the total cost per brake horse-power at the rated working load, and from which it will be seen that the cost of a suction gas-engine and plant of 100 B.H.P. to 110 B.H.P. is [illegible] 100 [illegible] 125 [illegible] for a 100 B.H.P. [illegible] engine. That is to say, the cost of the gas-engine is [illegible] by approximately 20 per cent. in order that it may perform a duty equivalent to a steam-engine of 100 B.H.P. rated working load.

This example serves to illustrate how necessary it is when comparing capital expenditures to place the comparison on "all fours" as regards power capacity.

Depreciation. A divergence of opinion appears to exist as to the annual charge that should be made to cover depreciation. It will be well to explain briefly what is here implied by the term depreciation. The depreciation charge is considered as the annual amount that should be written off the capital expenditure to cover the deteriorating value of the plant as regards obsolescence. This definition does not agree with general usage, inasmuch as wear and tear are not included. In the author's view the depreciation charge is solely dependent upon the anticipated economical life of the installation. It is considered that a uniform annual rate of 8 per cent., equivalent to 12½ years' service, fulfils these conditions, and that this rate should apply to all the prime movers under consideration, seeing that the commercial life is dependent upon the best practice irrespective of the type of engine. The amount written off annually is, therefore, 8 per cent. of the total expenditure given by the curves in Fig. 1.

The cost of insuring an installation is a small item and varies somewhat with the power unit and the insuring company. The insurance premium for engines usually covers breakages, but not wear and tear, and this fact should not be lost sight of when fixing the annual reservation for repairs.

Cost of Fuel.—Everyday figures only should be considered and failure in this respect is frequently the cause of erroneous estimates. In practice an engine seldom runs at the rated working load, having to cope alternatively with loads that may be temporarily greatly in excess and at other times considerably less. These practical conditions have a marked bearing upon the working costs, and particularly so in the case of an internal combustion engine.

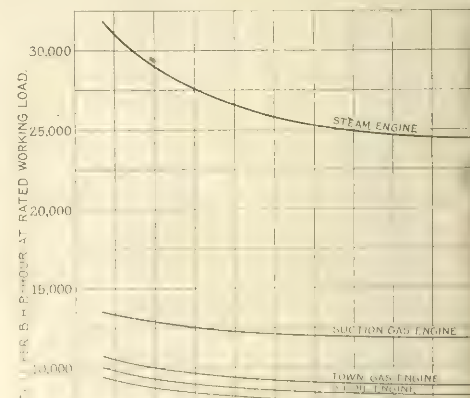


Fig. 2. -Fuel Consumption Curves.

The accompanying curves, Fig. 2, show the average consumption in B.Th.U. per brake horse-power-hour at the rated working load. These values, however, hold good only when these loads are carried continuously, and the extent to which modification is necessary under practical conditions is contingent upon the load factor and the peak load to be handled. These factors may vary widely, consequently each case must be considered upon its merits, but to effect a comparison a common overload of 35 per cent. will be assumed again. This condition necessitates the underloading of all the installations with the exception of the steam plant, that is to say, the mean working load will be below the rated working load to an extent dependent upon the maximum load capacity of the unit (see Table). This underloading increases the consumption, and the curves, Fig. 3, show the average percentage increase for a given decrease in load below the rated working load.

* Abstract of a Paper read before the Institution of Mechanical Engineers.

These curves clearly indicate the importance of the correct determination of the load factor, and the [illegible] necessity to consider similar load conditions in order that a true comparison may be made.

Table I. shows the increase in fuel consumption due to the underloading necessitated by an overload of 35 per cent.

Table I.

Installation.	Percentage of mean working load below rated working load.	Increase in consumption due to underloading. From Fig. 3.
Steam engine	Nil.	Nil.
Oil-engine	14·5	2·5
Diesel engine	14·5	2·5
Suction-gas engine	18·5	12
Town-gas engine	18·5	8

A further allowance must be made for stand-by losses, which will depend upon the frequency and length of the stoppages. This loss

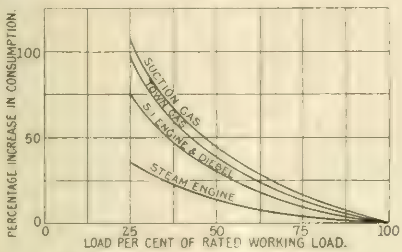


Fig. 3.—Consumption and Load Curves.

of course applies only to suction-gas and steam installations, and the amount may vary considerably according to the care exercised. The following values, expressed as a percentage of the fuel consumption at the rated working load for a working week of 60 hours, have been included in the working costs curves, Fig. 4:

Suction gas installations	Anthracite	8	per cent.
,, ,,	Wood	6	,,
Steam installations		15	,,

In cases where the plant runs continuously throughout the week, the losses would be considerably less and would be about one-third, assuming that the boiler or producer fires are kept alight over the week end.

The quantity of lubricant necessarily varies widely in practice, even in similar engines, due partly to the difference in manufacture and to the care or negligence on the part of the attendant. To cover amply these factors, the charges should be of a liberal nature.

In many localities a plentiful and satisfactory water service is not available and the cost of the necessary supply becomes a matter of moment. With a free and suitable supply the water may be returned [illegible]

[illegible]

[illegible]

S.I. and Diesel engines [illegible] 0·3 0·0036 ,,

[illegible]

[illegible]

The actual annual payments may form an appreciable portion of the running costs, and must in some cases exceed the estimated amount in view of the small provision made. This applies particularly to internal-combustion engines. There is little difficulty in citing instances of gas- and oil-engines in which the repair bill over, say, 5 or 6 years, has not exceeded 2 per cent. per annum of the engine cost. Such a figure, however, should not be taken as a basis. If the cost of repairs were entirely dependent upon wear and tear, 2 per cent., there is no doubt, could be taken as a general rate. Although internal-combustion engines have proved themselves to be thoroughly reliable in service, it is nevertheless a fact that they are more prone to minor mishaps than steam-engines,* and due allo ance must be made. For a well-designed gas- or oil-engine, ample margin for this contingency is given by an annual charge of 3 per cent. of the engine cost.

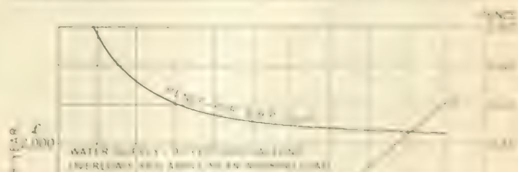
The following are the repair charges allowed for in the Working Cost Curves, Fig. 4:—

Diesel and S.I. oil engines [illegible]	3 per cent. [illegible]
Suction gas installations	3 per cent. [illegible] producer costs.
Steam installations	2½ per cent. [illegible] boiler and auxiliary costs.

In order to establish a relationship between the fuel prices that may be paid and to show the influence of the water charges upon these prices, the curves, Fig. 4, have been plotted. The curves A to F give the annual charges with water at 9d. per 1,000 gallons. The curve G represents the total annual working cost of a Diesel engine using fuel-oil at £3 per ton. It follows, therefore, the total amount that may be spent annually upon fuel to give even running charges for any one of the remaining installations, is represented by the length of the ordinate between the curve G and the cost curve of the particular engine considered. From the total fuel cost thus obtained the maximum prices that may be paid can be easily computed, and for plants of 250 B.H.P. mean working load are given in Table II. In the original Paper similar curves are given for water at another price.

Table II.

	Price of fuel.	[illegible]
Diesel engine	60 per ton	0·79
Solid injection oil-engine	76 ,,	1·0
Suction gas. Anthracite	29 ,,	0·38
,, Coke	21 ,,	0·27
,, Wood	8 6 ,,	0·113
Steam engine. Jet condensing	[illegible]	[illegible]
Steam engine. Surface condensing	14 ,,	0·184
Town gas engine	[illegible] per 1,000 cub. ft.	[illegible]



[illegible]

[illegible]

and consequently confines the use of the town-gas engine to cities in which gas is procurable at this low rate.

The calorific values assumed are :—

Anthracite	14,500	B.Th.U. per lb.
Coal (boiler)	13,500	,, ,, ,,
Fuel oil	18,000	,, ,, ,,
Wood refuse	5,800	,, ,, ,,
Town gas	540	,, ,, cub. ft.

Turning now to the high-compression solid injection-oil engine. A high price may be paid for fuel-oil, namely, £3 16s. per ton as compared with £3 for the Diesel engine, or a price some 26 per cent. higher, notwithstanding the higher thermal efficiency of the latter engine. The lower capital expenditure and other running charges of the soild injection-engine are responsible for this result.

With fuel oil at £3 per ton, the price of coal must not exceed on the average £1 5s. and 12s. per ton respectively for suction-gas and the larger steam-plants over 250 B.H.P. in order that the total annual running charges do not exceed an oil-engine of the solid-injection type, clearly indicating the wide field of action of this type of engine. The cheaper grades of fuel-oil of not less than 0·95 specific gravity alone are considered, as the charges of engines using the more costly and refined oils are appreciably higher and therefore commercially inferior.

Considering lastly the refuse suction-gas plant, the price of the fuel ranging as it does from 11s. to 13s. per ton, even with a free water supply, limits its use to industries in which the wood or other refuse is a waste product of the industry, for it is seldom possible to obtain a constant supply at these rates. Under this condition refuse installations are unquestionably the cheapest form of power.

The use of suction-gas as a heating agent is yet in its infancy, but very satisfactory results have already been obtained in laundries, woodworking factories, tinsmiths' shops, &c. The gas is drawn from the producer through a purifier and pumped to a gas-holder from which it is piped under slight pressure to any part of the factory, and by the aid of an air-mixer and burner used in a similar manner to town-gas. This feature is worthy of consideration, for it adds to the general utility of the suction-gas installation, and may in some cases effect an appreciable economy in the working costs.

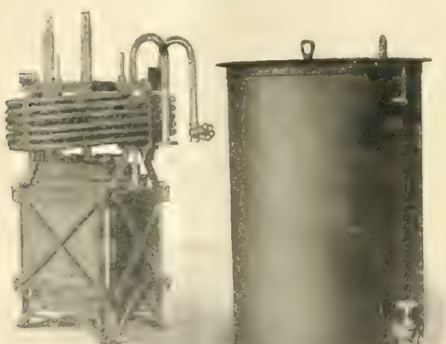
An objection sometimes advanced against the adoption of the internal-combustion engine for certain classes of works as, for example, tanneries, laundries, cotton mills, factory heating, &c., is its inability to provide a steam-supply. This difficulty has, however, been met to a large extent by the exhaust heated boiler which is capable of supplying about 2 lb. of steam, from and at 212°F. per brake-horse-power-hour of the engine.

SOME DETAILS OF CONSTRUCTION OF LARGE TRANSFORMERS BY THE BRITISH WESTINGHOUSE CO.

(*Concluded from p.* 153.)

Electric Furnace Transformers.

A number of heavy current transformers, of large capacity, for the operation of electric furnaces, are at present in the shops in various stages of manufacture. The British Westinghouse Co. has had exceptional experience during recent years in the construc



[illegible] Water-cooled Patent [illegible] (To Choke [illegible] amperes, 25 cycles.)

[illegible] transformers, and the present demand has developed [illegible] present day requirements for this [illegible] of work. Owing to the severe load conditions in electric [illegible] the construction must be very robust and the windings [illegible] supported.

[illegible] Transformer.

In Fig. 15 [illegible] transformer for [illegible] form a Scott connected [illegible] 11,200 [illegible] volts with [illegible] on the [illegible] volts on the [illegible] amperes. Attention [illegible] the high-tension [illegible] the voltage to [illegible] [illegible]

2,000 K.V.A. Oil-immersed Water-cooled Transformer.

A single-phase transformer is illustrated in Fig. 16, with special low-tension terminals for attachment of 'bus bars from the furnace. The high-tension pressure is 5,000 volts at 50 cycles. The low-tension pressure is normally 55 volts, but tappings are provided on the high-tension side to give 60, 65, 70 or 75 volts. The output at all ratios is 2,000 k.v.a., corresponding to a secondary current of 36,400 to 25,700 amperes.

The high-tension windings are of the usual B.W. standard shell type construction, and the low tension coils consist of one turn of copper strap.

This transformer is one of four recently supplied to Norway, and is of the oil insulated water-cooled type. The temperature rise on continuous full load is 40°C., and the full load efficiency is 98·5 per cent. The cooling coils (not shown in the illustration) are

Fig. 16. [illegible] Single-phase, Oil-immersed [illegible] Transformer [illegible] Mounting in Tank. Two Transformers [illegible]

mounted above the core around the terminal leads, and are so attached that the complete transformer with cooling coil may be lifted out of the tank as a whole. The coil supports, which are [illegible] heavy current transformers, subject to the [illegible] conditions that obtain in furnace work, are [illegible] construction. They are of the adjustable type and are shown in Fig. 16.

CORE TYPE TRANSFORMERS.

It must not be supposed from the fact that all the transformers described above are of the shell type construction, that the company have neglected the development of core type transformers. This is by no means the case. The total output of core type transformers during the past few years has been actually greater than that of shell type. Each has its own sphere, and the choice of type, especially where large units are concerned, must be made after full consideration of the merits of the individual case.

The British Westinghouse Co. have supplied a number of interesting installations of core type transformers. Mere reference to a few typical self-cooled ones must, however, suffice :—

Tata Hydro-Electric Power Scheme, 71 totalling 45,200 k.v.a., 6,600 volts, 50 cycles.

C. A. Parsons & Co. for Melbourne, 12 each 1,000 k.v.a., 20,000 volts, 25 cycles.

Kailin Mines, 3 each 1,500 k.v.a., 30,000 volts, 25 cycles.

Sydney Municipal Council, 3 each 2,000 k.v.a., 33,000 volts, 50 cycles.

Space permits of reference to only a few of the more general features of the British Westinghouse core type construction.

(a) "*Cross-over*" *Type.*—This consists of a number of coils in each of which the turns are wound side by side in short layers ; the wire having reached the end of a layer crosses over to the next. A double thickness of fibrous insulation is wound between adjacent layers.

(b) "*Section*" *Type.*—In this [illegible] high tension [illegible] "sections." In each section the turns are wound radially one over the other, producing a coil of several layers, but only one turn per layer. These sections are separated by fullerboard washers and connected in series to form a coil.

When [illegible] from one another by [illegible] provide large oil ducts.)

(c) *Single-layer "Spiral" Type.*—[illegible] single layer coils per limb, each coil being wound direct on a specially hardened insulating cylinder whose length approximates to the core length. These coils are arranged concentrically with respect to the low-tension winding and to one another. Treated hardwood strips separate the coils, giving mechanical support to the windings radially and ensuring thorough oil circulation.

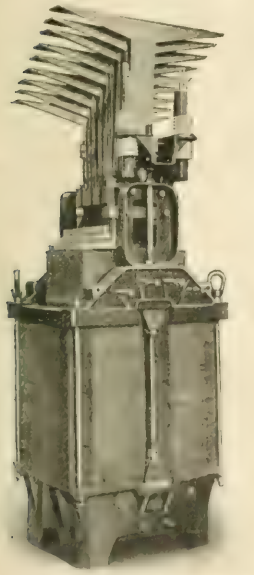


FIG. 16.—2,000 K.V.A. SINGLE-PHASE, OIL-IMMERSED, WATER-COOLED TRANSFORMER READY FOR FITTING WATER COOLING COILS AND MOUNTING IN TANK. [illegible]

FIG. 17.—1,640 K.V.A. THREE- TO SIX-PHASE, OIL-IMMERSED, SELF-COOLED TRANSFORMER, 6,600 VOLTS, 50 CYCLES. (External View [illegible] Box for High-tension [illegible] Cable.)

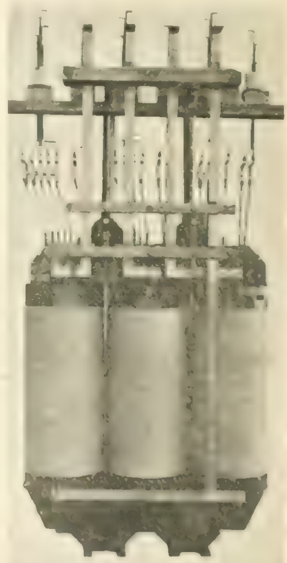


FIG. 18.—[illegible]

The magnetic circuits of these transformers are [illegible]

The [illegible]

All high-tension [illegible]

When [illegible]

(e) This efficient cooling permits of very great overload capacity.

(f) The winding is such that no appreciable shrinkage of insulation between turns takes place under working conditions giving practically a non-shrinkable winding.

Some idea of the sound design and construction shown in these transformers will be obtained from Fig. 18, which is referred to in greater detail below. In all other respects the details already given above in connection with the tappings and terminals, the tanks and other cooling arrangements, for shell type transformers applies to the core type.

In the case of transformers for operation in conjunction with rotary converters, magnetic shunts are usually placed between the high-tension and low-tension windings and are arranged on an improved plan recently patented.

Fig. 17 shows an external view of a large self-cooled oil-immersed transformer with high tension trifurcating box attached. The corrugated body of the tank is braced with strap irons arranged diagonally on each face, to prevent any liability to bulge by reason of the pressure of the oil in the tank.

Fig. 18 shows a core type transformer removed from tank showing the low-tension leads and special bracing and cleating arrangements for the leads. The high tension leads and multiple terminals are also seen at the back.

Fig. 19 shows a 20,000-volt core type transformer viewed from the high tension terminal side. The high tension windings are connected in delta with five regulating tappings on each phase. Attention may be drawn to the bracing and cleating of the high-tension leads for the delta connection and to the multiple terminals.

The standard core type frames of the British Westinghouse Co. are capable of outputs up to 4,000 k.v a. as self-cooled three-phase [illegible]

when the transformer is built and finished in the factory. As the coils and insulation settle down in the hot oil they may shrink, and in time may be no longer rigidly supported as when first assembled.

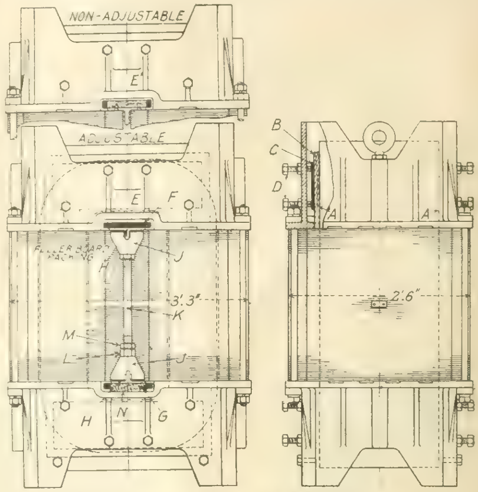


FIG. 20.—DETAILS OF SHELL TYPE COIL SUPPORTS.

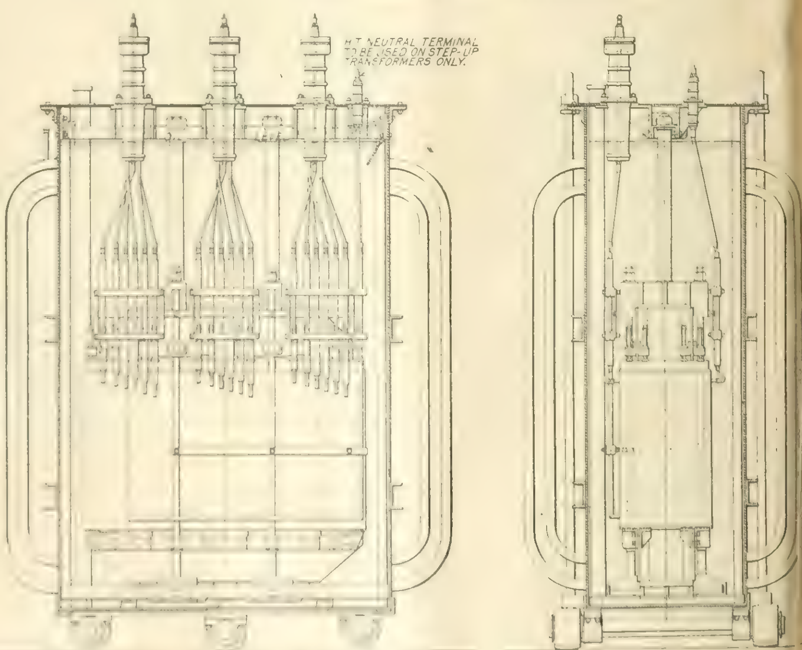


FIG. 19.—[illegible] Transformer [illegible]

FIG. 21.—3-PHASE CORE TYPE TRANSFORMER SHOWING DETAILS OF CORE TYPE COIL SUPPORTS.

[illegible] COIL SUPPORTS.

One of the [illegible] features of the British Westinghouse [illegible] support provided [illegible] the requirements of the large power [illegible] type of bracing and insulation [illegible] rigidly supported

As the [illegible] is very gradual and may go on for some time, it is desirable in order to maintain the original bracing to provide means for compensating it. The British Westinghouse Co.'s aim, as far as possible, is to construct and dispose the windings and insulation that the liability to shrinkage is reduced to a minimum. In the [illegible] type of winding, adopted where possible, all shrinkage is practically eliminated.

The adjustable method adopted for supporting the coils of shell type transformers has already been shown in the foregoing description, but is illustrated in detail in Fig. 20. These supports consist of two sets. The first compress the coil heads (or parts of the coil projecting beyond the core); the second brace the coil vertically, being applied to the inner periphery at the top and bottom. The coil head supports press on the vertical surfaces *A*, and consist essentially of treated hard wood packing blocks *B*, backed by a steel plate *C*, pressure being exerted by set screws *D*, which are tapped into the top frame of the transformer and held by lock nuts. There is a similar arrangement for the bottom frame.

The vertical coil supports are applied at the surfaces marked *E E′*. They consist of hard wood packing blocks *F*, *G*, covering the inner periphery of the coil at the top and bottom respectively. Pressure is exerted on these packing blocks by means of angle irons, *H*, backed by a pair of castings *J*, and these are spanned by an adjustable bolt *K*, with adjusting nut *L* and lock nut *M*. This adjusting nut is tightened up so that the coil supports are spanned rigidly between the top and bottom in the surfaces of the coil. The bottom wood packing block *G* extends beyond the width of the coil and rests on the bottom frame of the transformer at the surface marked *N*. This ensures that the whole of the weight of the coil is supported directly on the bottom frame and not on the laminated core, the support being transmitted through the device described above.

For core type transformers the most efficient means for the adjustable bracing of the windings is employed. Briefly, the arrangement consists in surmounting the coils of each limb with a massive steel ring which is fixed axially by adjustable stud bolts supported in a strong framework attached to the top yoke. The adjustable stud bolts are screwed down on to the rings thereby compressing the coils, and thus obviating any possible movement of the windings in service or on short circuit. Reference to Fig. 21 will make this arrangement plain.

THE PRESSURE REGULATION OF ROTARY CONVERTERS.

BY R. G. JAKEMAN, B.SC.

Summary.—Two methods of pressure regulation are discussed, (1) by means of reactance and (2) by means of a synchronous booster. (1) The principle of this method is explained shortly and several curves are given, showing [illegible] under varying conditions. (2) The principle of the synchronous booster is discussed at length, and vector diagrams are given showing its action under different conditions.

One of the chief disadvantages of the use of rotary converters is the difficulty of altering the voltage on one side independently of that on the other. Several devices have been brought forward to obviate this difficulty, and the two which are most generally used are (1) a large reactance inserted in the alternating-current circuit and (2) the alternating-current booster. The latter can be used for a fairly wide range of voltage variation, and the power-factor can be adjusted to any desired figure at any voltage within the range, while the former can only be used for comparatively small voltage variations, and the power factor is fixed at some definite value for each value of the voltage.

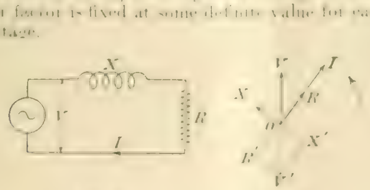


FIG. 1A. FIG. 1B.

EXPLANATORY DIAGRAMS.

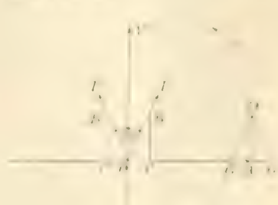
We will first of all consider the [illegible] of a constant voltage converter very briefly by means of vector diagrams, and in order to make these diagrams clear it will perhaps be advisable to discuss shortly the principles on which they are based. In the first place all the diagrams apply to only one phase of the system [illegible] A six-phase converter is considered as being made up of three single-phase systems, an assumption which is [illegible] usually the secondary of the transformer consists of three entirely separate phases. The direction of rotation of all diagrams will be taken as counter-clockwise [illegible]

The main principle underlying all vector diagrams, which may be taken as an axiom, is that the vectorial sum of all the induced E.M.F.s in a circuit is equal to zero. If, for example, a choking coil having no resistance be connected across an alternating pressure, a current will flow lagging [illegible] behind the applied pressure and a back E.M.F. will be induced in the choking coil which will exactly oppose the applied pressure. [illegible]

* La Cour, "Elements of Electrical Engineering," Vol. I, p. [illegible]

Now let us consider a circuit containing reactance and resistance as shown in Fig. 1A. The vector diagram is shown in Fig. 1B. OV represents the applied pressure V and OI the current I in a position which can be determined when the values of the resistance R and the reactance X are known. The part of the applied pressure consumed by the resistance is OR, in phase with the current, and the induced or back E.M.F. in the resistance must be OR', equal and opposite to OR. Similarly, OX is the part of the applied pressure consumed by the reactance and leads the current by 90 deg., whilst OX' is the induced E.M.F. in the reactance equal and opposite to OX. Now, as stated above, the vectorial sum of OV, OR' and OX' must be zero. Therefore, OV', the vectorial sum of OR' and OX' must be equal and opposite to the applied pressure OV. [illegible] OX', and the vectorial sum of OV and OX' balances OR'. In fact, these vectors may be treated in exactly the same way as the vectors of forces commonly used in statics.

For the sake of simplicity [illegible] E.M.F.s are shown in the diagrams. It must, therefore, be carefully borne in mind that the induced resistance E.M.F. [illegible]



[illegible]

[illegible]

* Hay, "Alternating Currents," [illegible]

In Fig. 2, OV represents the voltage impressed on the slip-rings, OA the resultant M.M.F. (and flux) and OE the back E.M.F. of the converter, which is equal and opposite to OV, since we are neglecting losses, &c. Since the voltage is constant in this particular case, and the speed is constant depending on the frequency, it follows that the flux in the machine must also be constant. Hence, the effective M.M.F. which produces this flux must be constant. At unity power factor there is no armature reaction, since the effect of the alternating current is neutralised by that of the direct current, and the resultant M.M.F. represented by OA in Fig. 2 is provided solely by the direct current excitation. If, however, the current OI lags behind the impressed voltage OV by an angle φ, then of the armature M.M.F. OB produced by this current, only the part CB, corresponding to the power component, is neutralised by the direct current, but the M.M.F. OC, produced by the reactive component, is not neutralised, and has a direct magnetising effect on the poles. OC acts in the same direction as the required resultant M.M.F. OA, but since the latter must remain constant for a constant applied pressure, as shown above, it follows that the direct-current excitation must be reduced to OG, such that $OG+OC=OA$.

Taking next the case when the current OI' leads the impressed voltage by an angle φ, we see that the unneutralised armature M.M.F. OC' is now in the opposite direction, and opposes the required M.M.F. Hence the direct-current excitation must be increased to OG', where $OG'-OC'=OA$.

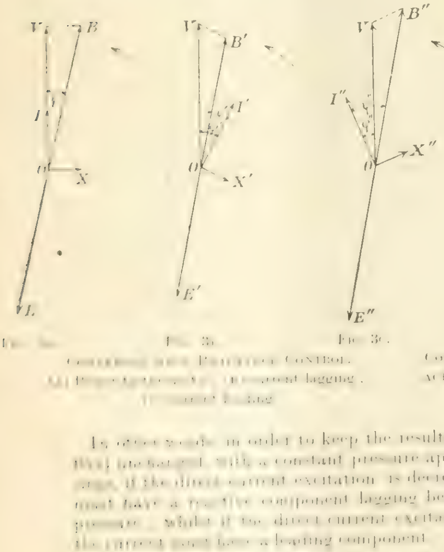


Fig. 2. [illegible] Fig. 3. Fig. 3c. [illegible] Converter without Reactance Control. [illegible] current lagging. [illegible]

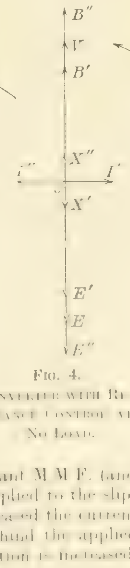


Fig. 4. Converter with Reactance Control at No Load.

[illegible] in order to keep the resultant M.M.F. (and flux) unchanged with a constant pressure applied to the slip-rings, if the direct current excitation is decreased the current must have a reactive component lagging behind the applied pressure, while if the direct current excitation is increased the current must have a leading component.

I. Reactance Control.*

The method of using these wattless currents to vary the voltage by means of reactance in the alternating current circuit can best be seen with the aid of [illegible] diagrams. The reactance may either be provided by means of separate choking coils or else, as is more usual, by [illegible] the transformers supplying the converter with [illegible]. [illegible]

In Fig. 3A, OV represents the secondary pressure of the transformer. If the power factor on the secondary side is [illegible] the current OI will be in phase with OV and the E.M.F. [illegible] OX [illegible] the current, as explained above. The vectorial sum of the secondary

* [illegible] Journal I.E.E., Vol. LV, p. [illegible]

pressure OV, the E.M.F. induced in the reactance OX, and the back E.M.F. of the converter OE must equal zero, and therefore the pressure applied to the slip-rings, which is equal and opposite to the back E.M.F. of the converter OE, must be the vectorial sum of the secondary pressure OV, and the induced E.M.F. OX. Completing the triangle this sum is clearly OB, when $VB=OX$. In this case the pressure has only been changed from OV to OB, but it will be noticed that the power factor in the converter itself has now become cos ψ leading.

If the current OI' lags behind the secondary pressure OV by an angle φ' (*see* Fig. 3B)* the E.M.F. induced in the reactance becomes OX', 90 deg. behind OI'. The vectorial sum of OV and OX' is now OB', when $VB'=OX'$. We see now that OB'

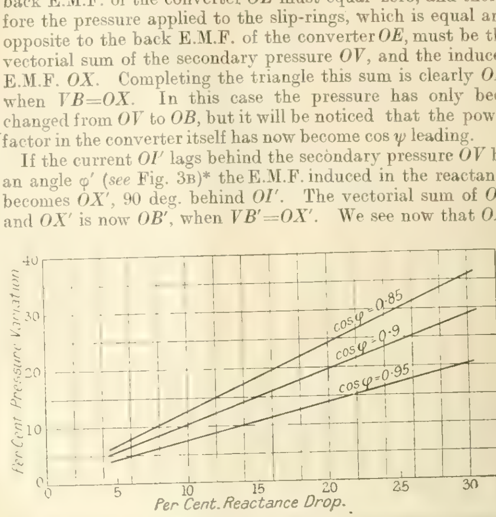


Fig. 5a. Reactance Required for Shunt Converter with Full-Load Power-Factors Equal at Maximum and Minimum Pressures.

the pressure applied to the converter is considerably less than the secondary pressure OV. It will also be noticed that the power factor in the converter, cos ψ' is lagging, and is higher than the power factor on the secondary side, cos φ'. In the same way, a leading current (Fig. 3c) will cause the pressure to be increased from OV to OB'', at the same time increasing the angle of lead from φ'' to ψ''.

The condition for no-load (neglecting losses) is illustrated in Fig. 4. When there is no wattless current, the total current is zero and the transformer pressure OV is not affected by the presence of the reactance. With a wattless lagging current OI', the E.M.F. induced in the reactance is OX', and the pressure applied to the slip-rings is reduced to OB', the vectorial sum of OV and OX', which in this case is their algebraic difference. With a wattless leading current OI'' the E.M.F. induced in the reactance is OX'', and the slip-ring pressure is increased to OB'', which equals algebraically $OV+OX''$.

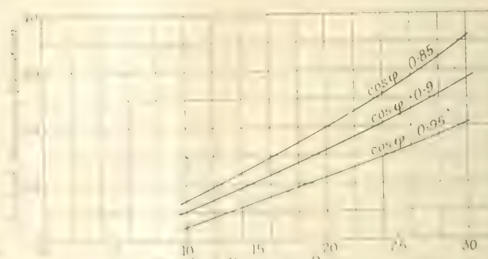


Fig. 5b. Reactance Required for Compound Converter with Wattless Currents Equal at No Load and Full Load.

Now the current can be made to lag or lead at will by altering the direct current excitation on the field, as was shown above. Hence, by varying the excitation, control is obtained over the

* It must be clearly understood that these diagrams are drawn on the assumption that the reactance is provided by means of separate choking coils placed between the transformer and the slip-rings. Owing to the fact that usually the reactance is provided by the leakage of the transformer itself, the power factor cos ψ cannot be measured. The power-factor at the [illegible] is cos φ, and on the high tension side it is different from cos φ, owing to the magnetising current of the transformer, which makes the high tension current lag more than the low tension current.

pressure applied to the slip-rings and therefore also over the pressure at the commutator, since these two pressures are connected by a practically constant ratio.

The direct-current excitation may be varied either by shunt or compound windings on the field. In the first case, any pressure within the range may be obtained at any load, and in the second the pressure varies automatically with the load, so that the pressure obtained depends on the load. It is clear that the power factor depends entirely on the pressure, and that for a given pressure and load, only one definite power factor can be obtained.

The reactance necessary to give the desired voltage regulation is given by the curves in Figs. 5A, 5B and 5C, which are

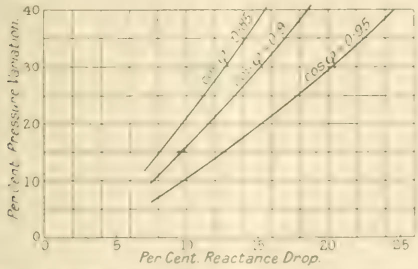


FIG. 5C.—REACTANCE REQUIRED FOR COMPOUND CONVERTER WITH UNITY POWER FACTOR AT THREE-QUARTER LOAD.

obtained by means of the diagrams in Fig. 3. By the percentage reactance-drop is meant the drop in the reactance caused by full-load current flowing, expressed as a percentage of the secondary pressure of the transformer. The voltage variation is expressed as a percentage of the lower direct-current voltage. Thus, a variation from 500 to 550 volts would be called a 10 per cent. variation. In working out these curves a drop of 4 per cent. has been allowed for the resistance

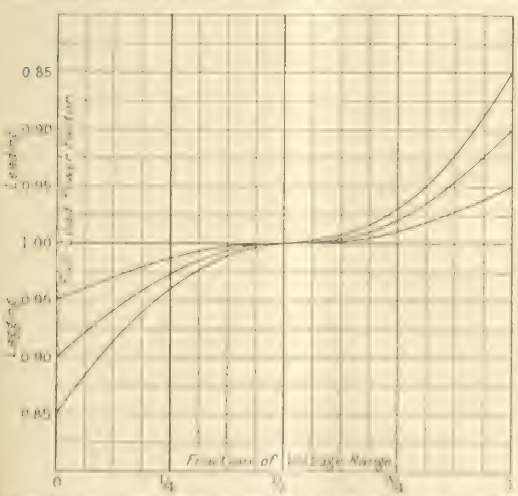


FIG. 6.—[illegible]

[illegible]

of the converter and transformer. [illegible]

[illegible]

Fig. 5B shows curves for a compound-wound converter, when the wattless current at full-load equals that at no-load. The voltage variation in this case is from no-load to full-load.

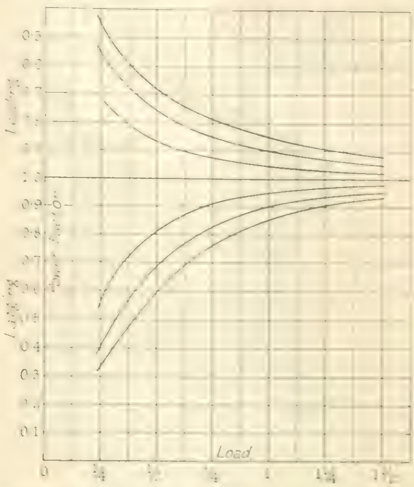


FIG. 7.—[illegible]

Fig. 5C shows similar curves for a compound-wound converter, but in this case it is specified that the power factor must be unity at three-quarters load.

The upper curves are inserted for the sake of illustration, but a full-load power factor of 0·85 is very seldom met with in practice. A voltage variation of more than 15 per cent. is seldom required, and it is not usual to have a [illegible] of more than 20 per cent.

Fig. 6 shows the full-load power factor of a [illegible] any point within the [illegible]

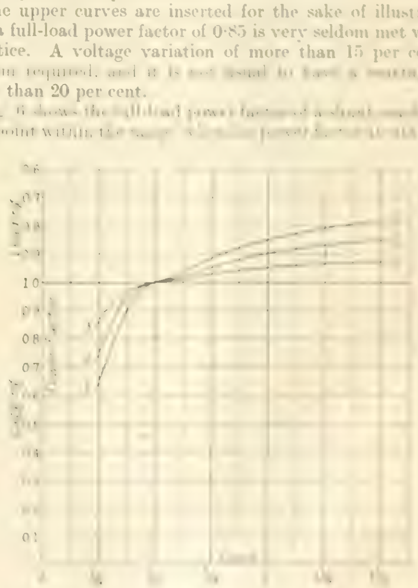


FIG. 8.—[illegible]

[illegible]

20 per cent. and the power factor were 0·9 at both ends of the range. We can therefore read off the reactance from Fig. 5A for a 20 per cent. variation on the curve for 0·9 power factor—*i.e.*, 20·5 per cent.

Fig. 7 is also for a shunt-wound machine, and shows the power factor for any load at constant voltage; that is to say, suppose the voltage variation is 400 to 440 volts with a power factor of 0·9 at both ends of the range, the full-load power

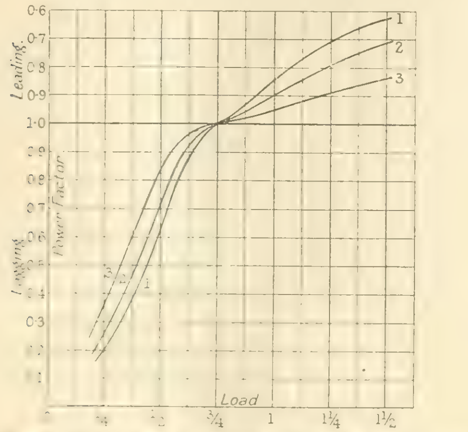
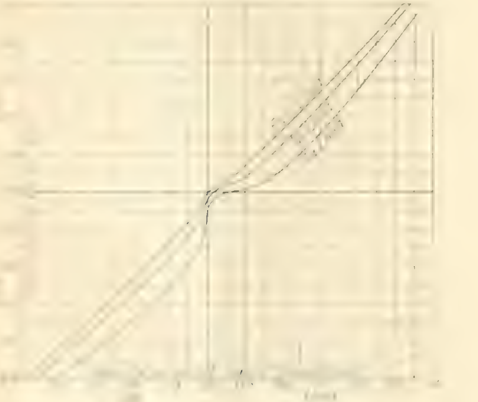


Fig. [illegible] Compound Converter at Any Load [illegible] Unity at Three-quarter Load.

factor [illegible] pressure can be found from Fig. 6. Taking, for example, 430 volts, which is three-quarters of the way up the range, we find the full-load power factor is 0·98 leading. Turning then to Fig. 7, we find a curve passing through 0·98 leading at full-load (interpolating, if necessary), and this curve [illegible] any other load at 430 volts.

Figs. 8A and 8B give the power factor at any load for a compound machine. Fig. 8A is for the case when the wattless



[illegible]

[illegible]

power factors on the high-tension and low-tension sides of the transformer at different loads, assuming that the magnetising current of the transformer is 10 per cent. of the full-load current. (The assumption is still maintained that the reactance is provided by means of separate choking coils.) The curves in Fig. 9B compare the power factor at the converter ($\cos \psi$ in Fig. 3) with the power factor on the low-tension side ($\cos \varphi$ in Fig. 3) for different values of the reactance drop.

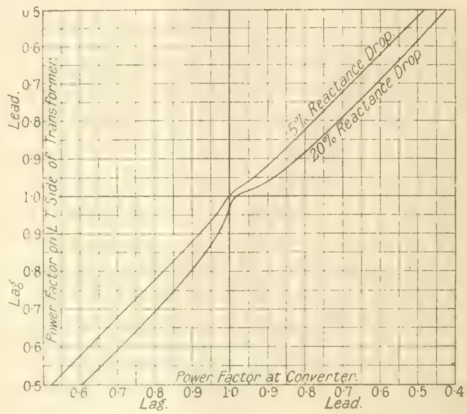


FIG. 9B.—RELATION OF POWER-FACTORS ON L.T. SIDE OF TRANSFORMER AND AT CONVERTER.

As an example, let us take the case of a shunt-wound converter with a 15 per cent. pressure variation and a full-load power factor of 0·9 leading on the high-tension side at the maximum pressure. From Fig. 5A we find that we require a reactance drop of 15 per cent. From Fig. 9A we then find that the full-load power factor on the low-tension side of the transformer corresponding to 0·9 leading on the high-tension side is 0·87 leading. Then, turning to Fig. 9B, we find that the full-load power factor at the converter corresponding to 0·87 leading on the low-tension side is 0·8 leading for a 15 per cent.

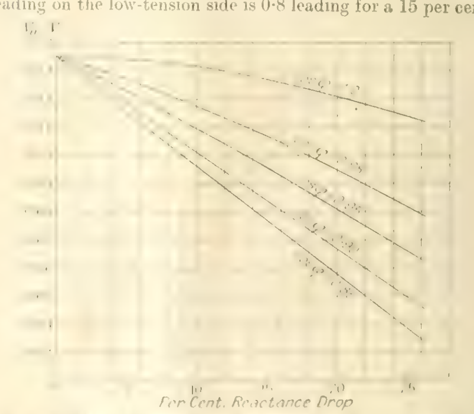


FIG. 10.—[illegible] TRANSFORMER PRESSURE TO MAINTAIN [illegible] FOR [illegible] SIX-PHASE CONVERTERS.

reactance drop, [illegible] this last power factor determines the copper losses [illegible] converter. For the same pressure at half-load we see from Fig. 7 the power factor is 0·76 leading on the high-tension side, and therefore from Fig. 9A the power factor on the low-tension side is 0·69 leading. The reactance drop at full-load is 15 per cent., and is, therefore, 7·5 per cent. at half-load, so that from Fig. 9B the power factor at the converter is 0·66 leading.

The method of finding the value of the secondary voltage of the converter is as follows :—

From Fig. 3c we have

$$OB''^2 = OV^2 + VB''^2 - 2 \, . \, OV \, . \, VB'' \, . \cos O\hat{V}B''.$$

Now, OB'' is the alternating E.M.F. of the converter at full load, and equals $1{\cdot}04 \times 0{\cdot}71 \times V_1 = 0{\cdot}735 V_1$, where V_1 is the maximum direct-current pressure required, 0·71 is the voltage ratio of the converter for four or six phase, and 1·04 allows for the resistance drop, as mentioned above.

$OV = V_0$ = the secondary pressure of the transformer on no load.

$VB'' = OX''$ = reactance drop, and may be represented by pV_0, where 100 p is the percentage the reactance drop bears to V_0.

$O\hat{V}B'' = 90° + \phi''$, and therefore $\cos O\hat{V}B'' = -\sin \phi''$, where $\cos \phi''$ is the power factor on the low-tension side of the converter. Hence we have

$$(0{\cdot}735 V_1)^2 = V_0^2 + (pV_0)^2 - 2pV_0^2 \sin \phi,$$

and this resolves into

$$\frac{V_0}{V_1} = \frac{0{\cdot}735}{\sqrt{1 + p^2 - 2p \sin \phi}}.$$

For the sake of convenience, this equation has been drawn in the form of curves in Fig. 10 for different values of cos φ.

Example.—Let us take the same figures as before, that is, a shunt-wound converter with a 15 per cent. pressure variation, a full-load power factor of 0·9 leading on the high-tension side

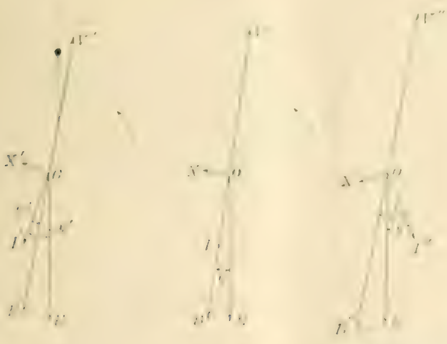


FIG. 11A. FIG. 11B. FIG. 11C.

[illegible]

[illegible]

the vectorial sum of OE and OX', and this balances the back E.M.F. of the alternating current network OV'. The alternating pressure has, therefore, been reduced from OE to OB'. The power-factor of the load supplied is cos φ′ on the low-tension side, where φ′ is the angle between OI' and OB'.

Similarly the cases for power-factor unity and for a leading current are shown in Figs. 11B and 11C. When the current leads the pressure is increased from OE to OB''.

These diagrams only apply when the inverted rotary is running in parallel with other synchronous machinery.

(To be concluded.)

CONTACT-MAKING VOLTMETERS.

[illegible]

[illegible]

[illegible] for unity power factor or any one definite power factor, the compen- [illegible] that of the contact-maker potential coil. Although only strictly accurate for compensating for line drop in a circuit without induc- [illegible] line-drop compensator. This is done because of the saving in first cost and station space.

[illegible] setting from that with low power factor to that corresponding to the [illegible] amount during the higher power-factor period by an amount approxi- [illegible]

[illegible]

[illegible] trouble.

[illegible]

[illegible]

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THE USE OF LOW GRADE FUEL.

In these days, when there are so many difficulties in transport and requirements to be met by collieries, power station engineers have found themselves using comparatively low grade fuel, not as a matter of choice, but because there was no alternative. There are many reasons, however, why low grade fuel should be used for power purposes, provided it can be employed with reasonable efficiency, regarded both technically and commercially. Unfortunately, the use of such fuel involves a number of difficulties. Owing to the higher content of ash in inferior qualities, the number of heat units for a given volume of coal becomes reduced, and consequently, from this point of view, if the output of the boilers is to be maintained the fuel should be passed along the grate more rapidly. On the other hand, if the speed at which the fuel passes along the grate is much increased the combustion is likely to be less perfect. Further, the high ash content causes a greater tendency to clinker, and a corresponding loss of combustible. The only reason why the ash usually obtained has quite a considerable calorific value is that particles of combustible matter become surrounded by incombustible material, and thus cannot be reached by the air. The higher the ash content the more this effect is likely to take place. Further, if the coal contains much sulphur the clinker that is formed is plastic, and may be very troublesome.

Leaving these difficulties on one side, there is the general objection that if the cost of transport is anything like a controlling factor it pays better to use a good coal rather than one that is inferior. Further, an inferior coal means that not only must more coal be handled, but also more ash, and consequently the costs are increased in this direction. Lastly a point is reached at which the mechanical stoker is not able to obtain the full rating of the boilers, and therefore the output of steam becomes reduced, which, unfortunately, is a common experience at the present day.

On the other hand announcements are made from time to time of attempts to utilise low grade fuel of one kind or another. For example, at the station of the Lehigh Navigation Electric Co. refuse coal from the breakers and washeries is being used. Specially designed grates and furnaces are employed for the purpose. Owing to the natural surroundings of the power house it is possible to run the coal in railway trucks directly on to the top of the power station, and similarly to remove the ashes from a lower level, so that ordinary coal and ash handling plant is avoided. Here the coal is of fairly high heat value (9,000 to 11,000 B.Th.U.), but it contains a large proportion of coal dust.

Another case is that of the Puget Sound Traction, Light & Power Co. In the neighbourhood there appears to be a large quantity of [illegible] fine coal, and consequently methods have been adopted by which it can be used in the form of fine dust. This dust is blown into the combustion chamber of the boilers. In order to render the coal suitable for the purpose it is dried and finely ground. The coal being in a fine state of subdivision the combustion should be very complete, as the air for combustion is able to reach every particle, and consequently combustible matter cannot very well remain protected by incombustible matter. As will be seen by reference to another column, the results are said to be satisfactory. It has generally been feared that the deposition of slag would prove an objection, and there is also the question of the deposition of fine ash. If the coal is finely ground it is obvious that a certain proportion of incombustible matter in a fine state of subdivision must pass into the flue gasses, and in all probability find its way into the atmosphere. Such dust would scarcely be hygienic, if in considerable quantity.

In this country most of the coal dust and fine coal is used for briquetting, and therefore is not wasted to any considerable extent. Possibly the grinding of low grade fuel may be one method of preliminary treatment to render it suitable for power purposes, though it may be questioned whether it would not be preferable, if possible, to adopt other means, such as washing on a more extensive scale, in order to eliminate the incombustible matter to a larger extent, even though this might prove somewhat costly.

REVIEW.

Mechanical Drafting. By C. B. HOWE, M.E. (London: Chapman & Hall.) Pp. x. + 147. 7s. 6d. net.

This volume contains about 150 pages of matter and is illustrated by 38 full size plates (10 by 8 in.) in addition to some 166 figures amongst the text.

A study of the book justifies the words in the preface, which state that it is not intended to be a manual of self-instruction but rather an assistant to the teacher. Most of our English manuals of instruction in machine drawing and design devote very little space to aiding a student to acquire the purely mechanical part of draughtsmanship, and teachers are left without much printed aid in making their students realise that the engineering profession has standardised conventional methods of expression. There is a distinct opening for a small volume on mechanical draughtsmanship, leaving the subject of machine design for subsequent treatment, and such a volume ought to be such that it could be said to be written for the student who comes fresh from a secondary school to a technical drawing class.

For such a book the volume under review possesses much to recommend it. Well printed on good paper, with the plates lined in a way to commend itself to any engineer's drawing office, it possesses eight out of ten chapters which every machine drawing student ought thoroughly to understand. If these eight chapters could be separated from the remainder, and bound in a loose cover, the book would become two-thirds of its present size and could be marketed at half the price.

The text is set out in ten chapters, which deal respectively with Materials and Instruments, Principles of Drafting, Geometry of Drawing, Descriptive-Geometrical Drawing, Working Drawings, Machine Drawing, Plan Drawing, Plot and Map Drawing, Pictorial Representation and Sketching, and Blue Printing. An admirable feature is that each paragraph is numbered so that reference by a teacher is facilitated.

Chapter VII. on Plan Drawing is suitable only for fairly advanced architectural students, and for such the rest of the book would have no appeal. Chapter VIII. deals with surveying and the plotting of the results given in a Field Book. In the chapter illustrations of a theodolite and level are given together with their use; this is rather wasteful in a book of this kind, as it is much more thoroughly done in manuals of surveying, and no student reading this book only would be enabled to grasp the correct methods of running levels or making a traverse.

Apart from Chapters VII. and VIII. this book will be found very useful by teachers, and also to students who wish to improve their draughtsmanship by practice in their own homes.

A. J. M.

OBITUARY.

WILLIAM DUDDELL.

It is with very great regret that we record the death of William Duddell at the early age of 45. He passed away last Sunday, and his death will come as a shock to those who have not been aware of his failing health during the past year.

Duddell was born in London in 1872, and after education at private schools and at the Collège Stanislas, Cannes, he served his apprenticeship with Messrs. Davey, Paxman & Co., of Colchester, from 1890 to 1893. He then went to the City and Guilds Central Technical College at South Kensington, where he studied from 1893 to 1900 under the late Prof. Ayrton, obtaining a Whitworth Exhibition in 1896 and a Whitworth Scholarship in 1897. In 1913 the Fellowship of the City and Guilds of London Institute was conferred upon him. He remained at the College considerably longer than usual, engaged in original experimental work, and it soon became apparent that he possessed unusual talent as an experimentalist. It so happened that Prof. Ayrton and his staff were engaged on the delineation of alternate current wave forms during Duddell's studentship, and Duddell became intensely interested in the subject; his skill as a mechanic combined with [illegible] theory were of great use in this problem, which led to the development of his oscillograph. Then he turned his attention [illegible] in 1899, when working at the College, he read, in conjunction with Mr. (now Prof.) E. W. Marchant, a Paper before the Institution of Electrical Engineers entitled [illegible]

WILLIAM DUDDELL.

[illegible]

[illegible]

of these waves was not very high. It remained for Poulsen to shorten the wave-length sufficiently for telegraphic purposes, and this he did by introducing an atmosphere of hydrogen and other modifications.

It was only natural that his connection with undamped oscillations should cause Duddell to turn his attention to wireless telegraphy. He became keenly interested in this new subject, and in 1905 he read a Paper before the Institution of Electrical Engineers with Mr. J. E. Taylor on "Wireless Telegraphy Measurements," in which numerous measurements were given of the currents in a receiving aerial under various conditions. In work of this character his skill in devising and making new instruments was a great asset. Two instruments of this kind were described by Duddell before the Physical Society in 1904. Both were designed for [illegible] ting currents. One of these depended on the principle of the Ayrton-Perry [illegible] strip was only 0·001 in. in thickness; consequently the thermal capacity was very small, a reasonable [illegible] a reflecting instrument with only small alternating currents, and the creep [illegible] Essentially, the arrangement [illegible] only 1 in. in length, were [illegible]

[illegible]

[illegible]

Current of an Inductor Alternator," the design of an alternator for a frequency of 2,000, and the use of alternating currents superposed on the supply current for controlling apparatus at a distance from the central station, in the last of which he was associated with Messrs. A. H. Dykes and H. W. Handcock.

Duddell was an active member of many societies. After having passed through all the then grades of Membership, Student, Associate, Associate Member and Member, Member of Council and Vice-President, he was elected President of the Institution of Electrical Engineers at the early age of 40, holding office for two years in succession. His first presidential address was of the orthodox kind, but the second gave his audience a rare opportunity of witnessing instructive experiments on "Pressure Rises" most skilfully performed. Among the apparatus then shown was an electromechanical model of the arc, which was a most ingenious device for reproducing mechanical analogies of the various well-known and somewhat puzzling characteristics exhibited by the electric arc. The up-to-date nature of the Institution library, which was by no means its character some few years ago, was largely due to the efforts of Duddell as chairman of the Library Committee. In 1907 he was president of the Röntgen Society. For a time he was a vice-president of the Physical Society, and was hon. treasurer of the Society from 1910 up to the time of his death. He was hon. secretary to the delegates to the International Electrical Congress at St. Louis in 1901, and one of the hon. secretaries to the International Conference on Electrical Units and Standards which met in London in 1908. He was also president of the Commission Internationale de Télégraphie sans Fils, and in 1914 he published an outline of the investigations contemplated by that body, but which were, unfortunately, interrupted by the calamity of war.

Among his honours may be mentioned gold medals for his oscillographs at the Paris Exhibition of 1900 and at St. Louis in 1904, and the Hughes medal of the Royal Society in 1912. He was elected a Fellow of the Royal Society in 1907. He was a member of the Advisory Council for promoting Industrial and Scientific Research, and of the Board of Inventions and Research of the Admiralty. Recently the honour of Commander of the Order of the British Empire was bestowed upon him, but it will generally be felt that his name should have appeared in some more distinguished class.

Although the value of his work was quickly recognised, he always remained unassuming, and his lightness of manner made him readily approachable by all and sundry. Being [illegible] he gave himself unreservedly to his work; and it [illegible] this was his only hobby, which made it all the more difficult for his friends to induce him to put work aside when it became evident that his health was failing. The end came suddenly and those who knew him will feel some relief that it should have been so. He [illegible] a brilliant experimentalist, to whom the electrical industry owes a debt of gratitude, and whom [illegible], can ill afford to lose.

Telephone Connections for Military Camps. [illegible]

ELECTRICAL DISTANCE THERMOMETERS IN THE REGENT PALACE HOTEL.

In 1915, when the Regent Palace Hotel was opened, an article appeared in our pages describing the engineering plant in this building (THE ELECTRICIAN, June 25, 1915, page 431). Unfortunately at that time, owing to the conditions caused by the outbreak of war, the instruments manufactured by the Cambridge Scientific Instrument Co., Ltd., for measuring temperatures in different parts of the building had not been finished, and the special control room in which readings from all the thermometers can be taken by the engineer in charge of the plant was not completed. The thermometer installation has, however, now been in operation for about two years, and the following brief description will be of interest.

The control room, which is well lighted, is about 20 ft. long by 8 ft. in width, and down one side of it are fixed the switchboards carrying the temperature indicators and recorder, from which the temperatures at 130 different points scattered throughout the building can be determined. Wet and dry bulb thermometers of the electrical resistance type are fixed in the public rooms and corridors and are wired to the main switchboard of 100 points, seen in the foreground in the illustration. By means of a plug connection any one of these thermometers can be connected to the indicator, graduated to cover a range of temperatures from 20° to 100° F., which is seen in the middle of the switchboard. The 22-point switchboard to the right of the main switchboard in the illustration is connected to thermometers measuring the temperatures at different points in the hot water supply system and also certain

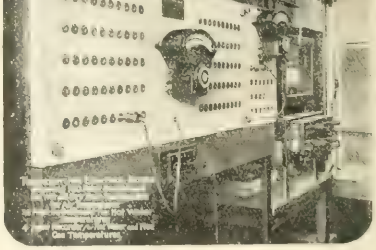

FIG. 1.—THERMOMETER SWITCHBOARD.

steam and flue gas temperatures. This indicator is fitted with two scales with ranges 100–250° F. and 250–600° F. respectively. Readings are taken at regular intervals from all the thermometers connected to these two switchboards. The recording instrument shown on the extreme right of the illustration is arranged so that by means of a special control board the readings of any four of ten thermometers can be recorded on a 24-hour chart, the range being suitable for measuring hot water, steam, or flue gas temperatures. The large extent of the complete installation is shown by the fact that over two miles of leads were required to connect the various thermometers to the switchboards.

On the other side of the control room is a water level indicator made by the Cambridge Scientific Instrument Co., Ltd., to the design of the consulting engineer, Mr. A. H. Barker, B.A., B.Sc., Wh.Sc., professor of heating and ventilation engineering at London University, under whose direction the thermometer plant was also installed. With this indicator it is possible to observe at any time the level of the water in the 16 storage tanks fixed in the building. The apparatus consists of a very small electrically driven air pump, which forces air into a small cylindrical reservoir at a pressure of about 3 lb. per square inch. A number of gas pipes, each controlled by a cock with a very small passage, lead from this reservoir one to each tank. Each pipe dips to the bottom of its tank. When any cock is opened a stream of air bubbles is forced into the bottom of the water in the corresponding tank. The pressure needed in the pipe to force the air [illegible] water gives an exact indication of the depth of water in the tank. This is measured in each case by a suitably graduated mercury gauge. The reading of the mercury gauge on the board of the apparatus when the cock is opened thus gives the exact depth of [illegible]. The apparatus is all contained in the case

shown in the photograph. The cocks at the bottom of the photograph are the controlling cocks, and the mercury gauges seen on the front correspond to the cocks at the bottom.

The convenience and economy of a centralised control system of this kind in a large building like the Regent Palace Hotel is obviously very great, as without some such system the temperatures in the various parts of the building could not be kept under close

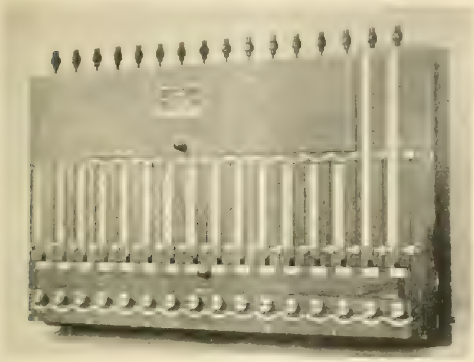

FIG. 2.—PNEUMATIC LEVEL INDICATOR FOR TANKS.

observation without a great expenditure of time and labour. Instruments of a similar kind have recently been installed at the Hotel Cecil for taking temperatures on the refrigerating plant, but we believe that the Regent Palace is the first hotel in Great Britain to utilise electrical thermometers on a large scale throughout its premises. It is, however, probable that in the near future the advantages of this form of temperature control will lead to its adoption in an increasing number of public buildings in this country.

UTILISING COAL MINE WASTE.*

BY HENRY [illegible]

Prompted by the large amount of unmarketable fine coal which is piled up at numerous points by coal mines, the Puget Sound Traction, Light & Power Co. has investigated the practicability of burning powdered coal. The coal is a form of lignite particularly adapted to use in the powdered form owing to the high volatile content and the very high fusing point of the ash. To prepare the coal for burning it must first be thoroughly dried, and the moisture content reduced to approximately 1 per cent. before it can be properly pulverised. It must then be ground until approximately 85 per cent. will pass through a 200-mesh screen and 95 per cent. through a 100-mesh screen if the best results are to be obtained. It should then be fed directly to the furnace, or, if transportation or storage is necessary, it should be kept air-tight so far as possible to prevent absorption of moisture.

The coal, which has been investigated by the Puget Sound Company, is dried and pulverised by the [illegible] at its briquetting plant, near Renton, which is equipped with a Raymond pulverising plant. It is then loaded in a box car having a metal-lined hopper. The car is spotted at the steam plant over a chute which is connected to the car by a flexible hose. The chute feeds a small metal-housed conveyer which elevates and dumps the coal into a bunker adjoining the power plant. From the bottom of this the fuel is fed by means of two motor-driven screws into a 3 in. (7·62 cm.) supply pipe, through which it is then blown to the front of the furnace. At this point the fuel is discharged into the side of an injector consisting of a 16 in. (38·1 cm.) drum surrounding a nozzle on the end of a 10 in. (25·4 cm.) air-supply pipe. Dampers are provided in the drum and air pipe to regulate the amount of air supplied to the combustion chamber. In starting operation the coal dust is allowed to drop on an oil flame, although any small fire built under the fuel discharge pipe would have the same effect. An extended Dutch oven with a broad arch is used to assist ignition as considerable combustion space is required to secure satisfactory results, a parabolic shape being most desirable. Fire cannot travel back into the fuel supply pipe as long as the rate of air supply is greater than that of fuel propagation.

A record of a 12·8-hour test on the equipment is given herewith. The duration of the test was limited by the facilities for storage and handling of the fuel. The coal was weighed in the car as delivered to the plant and the net weight determined by a subsequent weighing of the car after unloading. The test was run until all coal was consumed. The water was measured by a Venturi water meter installed in an individual feed line to the boiler, and all instruments were checked for accuracy before starting.

During the test it was noted that the boiler could be forced to 200 per cent. of rating without any apparent damage to brick setting or tubes. The stack was perfectly clear under these conditions, and there was no fusing of the ash. About one-third of the ash was found deposited in the second and third passes of the boiler, none whatever being found to have collected on the tubes.

The results of the experiment tend to refute most of the adverse criticism of this method of burning coal. There was no formation of slag in the furnace or on the tubes, there was no shower of cinders and ashes emitted from the smokestack, and there was no damage done to the boiler from heavy overload under these conditions.

Test of 300-h.p. B. & W. Boiler Burning Powdered Coal.

Coal Analysis.

Moisture.	Volatile.	Fixed carbon.	Ash.	Sulphur.	B.T.U.
1·4	37·2	47	10·4	0·56	11,760

Ash Analysis.

SiO_2	44·00 [illegible]	7·75
Fe_2O_3	10·45 [illegible]	2·40
Al_2O_3	32·88	

Screen Test of Coal.	Per cent. of coal passing.
On 100 mesh	[illegible]
Through 100 on 200	[illegible]
Through 200	[illegible]
Duration of test (hours)	12·8
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
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[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

* [illegible]

[illegible]

EDUCATION OF APPRENTICES.

On the 18th ult. a representative deputation from the North East Coast Institution of Engineers and Shipbuilders waited upon the President of the Board of Education (Dr. H. A. L. Fisher, M.P.) [illegible]

[illegible]

sentative body in consultation with the local education authorities. The Institution endorsed in the strongest possible terms the regulations of the Board of Education which required that a reasonable proportion of the members of the teaching staffs of such schools must have had practical trade experience of the occupations for which the schools furnished educational preparation. The Institution regarded it as equally important that the inspection staff of the Board of Education charged with the supervision of the work of these and allied schools should be technical men with experience in the industries. It was also urged that the advisory body just referred to should have full opportunity of consultation with the inspection staff and with the chief administrative official immediately responsible to the Secretary of the Board of Education. Mr. Rowell referred in detail to the Board's regulations for junior day technical schools and expressed the view that the declaration in the regulations that they were "not intended to promote the establishment of courses planned to furnish a preparation for the professions, the Universities or higher full-time technical work" was open to grave exception, as viewing the work of such a school as lying within a cul-de-sac. The Institution's scheme regarded such schools as places where the preparatory education of a prospective engineer or shipbuilder should be well and truly laid and where provision was made for the continuance of that education in a senior technical school during the apprenticeship of the brightest pupils and continuing to the University. They realised that, if the scheme of education indicated in the report came into force, the engineering and shipbuilding companies concerned would be called upon to bear not only the cost of providing their apprentices with the facilities necessary under the scheme but, also, a heavy share of the increase of taxes thereby entailed. They believed, however, that the extra expense involved would be returned to the community in a far higher degree, on the one hand by the greater skill of the workman and, on the other, in the broader mental outlook, balance and initiative of the individual. They would like to see such a scheme adopted nationally but, if that could not be done at first, they were prepared to recommend its adoption on the North-East Coast. The old family relations of master and apprentice, which raised craftsmanship to a dominating height, were gone, but they could at least see that the neglect and exploitation of apprentice labour that had largely prevailed for half a century died also. The close personal instruction of the old days of the guilds could, at any rate, be replaced by a high standard of collective training with, where the size of the works allowed, a suitable person to act as mentor and guide to the apprentices.

SIR PERCY GIROUARD, on behalf of the North-East Coast Engineering Trades Employers' Association, endorsed the proposals of the Institution. He realised that the scheme would mean a great addition to the number of [illegible] departments, but he thought that most companies were prepared to meet that expense, as the Institution's proposals would give them much more highly-educated apprentices, who would have much greater chances of going into the higher spheres in engineering. [illegible] WATTS, MR. W. H. DUGDALE, MR. GEO. JONES and MR. M. C. JAMES spoke in endorsement of the Institution's scheme. SIR JOHNSTONE WALLACE, on behalf of the Newcastle Education Committee, said that authority heartily and enthusiastically supported the scheme and was prepared to carry it out.

[illegible] he regarded that deputation as a very encouraging sign of the interest large employers of labour were taking in the promotion of technical education in this country. He was sorry to [illegible] technical education was concerned. However, it was part of the duty of that Board, in co-operation with the industries and with local education authorities, to dispel that suspicion. He would give very careful consideration to the points raised [illegible] regulations governing the junior day technical schools. The point with respect to finance could not be settled without consultation with the Treasury. Hitherto a certain number of [illegible] had provided continuation schools [illegible] he had heard an instance in which an employer who had taken that step had regretted it. Employers who did [illegible] to the competition of other employers who had not taken the step; but he believed that, when the [illegible]

[illegible]

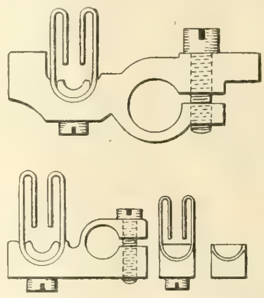
[illegible]

CORRESPONDENCE.

FAILURE OF FUSE CLIP HOLDERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: A very valued client of ours has called attention to the correspondence on switch and fuse clips, which has recently appeared in your columns. May we suggest that failure of the clips which are bent to a sharp right angle is due solely to the sharpness of the bend. Let any one interested bend a couple of dozen bits of hard copper tape to a sharp right angle and then bend them slightly backwards and afterwards examine the inside bend with a magnifying glass; he will probably find a considerable percentage show signs of fracture. As to remedying the evil, we think, Mr. Editor, that the samples we enclose will at least satisfy you that the difficulty



THE "CANTIE" SWITCH AND FUSE CLIP. (Registered.)

has been overcome in this design, which we manufacture for our own switches only. There is no severe bend to distress the metal, and the form is such as to retain the full elasticity of the copper to the end of its life. We have used this clip very largely and up to the present have had no complaint of its fracturing either on switch or fuse gear. With regard to the smallest sample sent, this is a design registered only a few weeks back for use with a new heating switch. We enclose a sketch in case you care to reproduce.—We are, &c.,

THE CANTIE SWITCH CO., LTD.

Nottingham, Oct. 29.

CO-OPERATION BETWEEN ELECTRICITY SUPPLY AND GAS UNDERTAKINGS.

At the meeting of the National Gas Council which was held at the Central Hall, Westminster, last week, the Executive's Committee report contained the following announcement in regard to co-operation between electricity supply and gas undertakings:

A sub-committee dealing with fuel resources report that the opinion of a number of eminent scientists and authorities on electrical supply, who have attended the meetings of the committee and given their views with regard to the possible development of co-operative working by the electrical and gas industries, is strongly in favour of co-operation and joint-working, especially on the lines of gasworks supplying electric power undertakings with heat units. A report, which it is proposed to submit to the Government, is now in course of preparation, and it is anticipated that it will set forward some such suggestions as the following:—

1. In the interests of national economy, the desirability of all coal of a bituminous character hitherto used directly as fuel being first treated for the extraction of its by-products.

2. Where gas undertakings are in proximity to electric power stations an endeavour should be made to enter into an arrangement with electric undertakings for the supply of fuel for steam-raising in the form of coke or breeze.

The Executive Committee consider that if such a system could be made the subject of experiment in different parts of the country, it would go a long way to establish the practicability of such co-operation, and are much indebted to Sir Arthur Duckham for his interest and assistance in connection with the subject. A sub-committee is now investigating the question of tar burning for steam-raising, and the Admiralty are to be represented on this sub-committee.

BIRMINGHAM ROAD WIDENING AND TRAMWAYS.

At a meeting of the City Council last week the Public Works Committee submitted a long report recommending the widening of the arterial main roads, the construction of tramways, &c.

Mr. TALBOT, who presented the report, said the traffic problem of the city was one of the most important that would have to be faced in the immediate future. The main roads were being used for purposes for which they were not designed: they were inadequate for the traffic, and in many respects they were dangerous to the people who used them. Hitherto the policy of widening thoroughfares had been of a haphazard character. In the last 10 years about half a million of money had been expended on that policy, but the results were not worth the cost. The present was an opportune time for commencing a street widening policy on definite lines. The Council should now determine the width of the roads and lay down a rule for future building. It should be remembered that the industrial expansion of B rmingham had been phenomenal. The expert consulted by the Corporation 15 years ago on the tramways advised that by 1921 the traffic receipts might be estimated at £200,000 a year, but last year their receipts were £880,000, and this year they would exceed a million. The whole of the tramways would soon run to the city boundaries, and thus the tramway traffic would be largely increased. With the development of the tramways must be considered the great housing problem, for one object of the tramways was to carry people from the centre of the city to more healthy districts and better surroundings. Facilities must be provided, therefore, for tramway traffic free and uninterrupted by any other traffic.

TRAMWAYS AND SLEEPER TRACKS.

An alternative method of tramway construction was the sleeper track system, which had many advantages, and the manager of the tramways was of opinion that by the adoption of that system £100,000 could be saved annually on the maintenance of the tramways. But what the Council had to consider at the moment was not which system of tramways should be adopted, but the widening of the streets for the accommodation of the traffic. He hoped that, once the improvement was begun, they would soon see something achieved which would be an object lesson. He hoped the Council would take a broad view of the question, and not allow itself to be distracted by details. Difficulties there would be, hardships there might be, but the difficulties would be surmounted and the hardships as they arose would be compensated for.

Mr. HARRISON BARROW, who seconded the resolution, said that from a tramway point of view it was obvious wide roads were an immense advantage, and the Tramways Committee as a whole approved of the suggestions made by the committee. He believed the estimate of saving £100,000 annually on tramways if all were laid upon a separate sleeper track was a conservative one, and he thought in all probability the saving would be greater. There [illegible] of the trams, and he felt they were [illegible] It must be remembered, however, [illegible] and that made all the difference. [illegible] would be reduced to a minimum. [illegible] which he regarded as one of the most [illegible] forward for a long time.

Mr. S. JAMES moved [illegible] should approve the proposal [illegible] the arterial road [illegible] that of the separate tramway track system and the 110 ft. roads in the built up areas [illegible]

Considerable discussion ensued, [illegible] adjourned.

PARLIAMENTARY INTELLIGENCE.

IMPORTS OF TUNGSTEN WIRE.

In the House of Commons on the [illegible] asked the President of the Board of Trade [illegible] British [illegible] of tungsten wire [illegible] had been [illegible] be readily obtained in this country [illegible] petitive prices, and when it was [illegible] of money out of the country.

In reply [illegible] not been given for several months [illegible]

WATER POWER IN IRELAND.

In reply to a question [illegible] the [illegible] Ireland was [illegible] prospects of using power generated from water in other than local industries would be comparatively small, except by long distance electric transmission, and [illegible] to advantage.

BOARD OF TRADE ELECTRIC POWER SUPPLY COMMITTEE.

In reply [illegible] stated that he could not say when the Board of Trade Electric Power Supply Committee would be in a position to report, but there would be no unavoidable delay in view of the great importance of the subject.

Dublin United Tramways. [illegible] including buildings, overhead wires, &c.

LEGAL INTELLIGENCE.

Workmen's Compensation.

At Preston County Court recently Judge Sturges, K.C. (sitting with Dr. Irvin Sellers, as medical referee), was asked to review an award of compensation made in favour of Thomas Cross, electrician, who had been injured by his hand coming into contact with a live wire, carrying electric current of 220 volts, on June 23, 1914. The resultant shock brought on neurasthenia, and by agreement £1 per week had been paid to him. His employer (Mr. J. Berry) asked that the case should be reviewed.

Medical evidence showed that respondent was in fair physical condition, and that light outdoor work would benefit him. He was still suffering from neurasthenia as the result of the shock, but brooding over his condition was likely to make it worse.

Respondent said he still suffered from dizziness, falling in the street and occasional loss of memory. He had tried gardening and cycling, but he fell off the cycle through dizziness, and gardening caused violent pains in the head.

Medical witnesses for respondent said his condition was still so serious that he was unfit for work of any kind.

His Honour said respondent [illegible] and he was not satisfied he was capable of doing light work [illegible] was able to obtain such work in the open market. He, therefore, gave an award in favour of respondent, with costs.

M. Steeples v. Notts & Derbyshire Tramways Co.

At Derby County Court [illegible] defendant company for loss and injury to cattle. Plaintiff's son was driving a herd of cows in Codnor, early on the morning of July 26, when [illegible] driven. The driver did not attempt to pull up until he was within four or five yards of the animals. Two of them were knocked down, and one was dragged under the car for 16 yards, being fatally injured.

After hearing the evidence, his Honour found that the car was going [illegible] stituted reckless driving in the circumstances. He accordingly entered judgment for plaintiff.

Wigan Tramway Accident.

At W[illegible] arising out of the accident on the Corporation tramways system on [illegible]

Co-operative Electrical and Industrial Tra[illegible] [illegible] Lynn the [illegible]

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

[illegible] from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

[illegible] from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

[illegible] SPECIFICATIONS.

5,319 PONS, V. Construction of sparking plugs. (14/5/15.) 100,482.
8,618 BARTLETT & SIMPSON. Anti-rheumatic or electric knitting needles. (19/6/16.) 109,628.
9,172 THOMAS, J. G. P. AND THOMAS TRANSMISSION, LTD. Differential bevel gearing [illegible]
9,263 VICKERS, LTD. AND HALSTEAD, R. L. Electric regulators or rheostats. (30/6/16.) 109,818.
11,844 DENTON. Method of producing and controlling high temperatures in electric furnaces. (21/8/16.) 109,639.
Consists in forming an ionising path for the electric current by chemical agency, using substances or compounds which, when in a state of fusion or liquid or blended with others, set up free ions, and controlling the temperature obtained by additions to the charge of the furnace to an extent to suit the temperature required.
12,781 WESTERN ELECTRIC CO. & REINKE. Telephone systems. (9/9/16.) 109,640.
13,343 JONES. Method of forming metal electrodes used in electric arc soldering and deposition of metals. (20/9/16.) 109,652.
13,429 DEVENTER, R. H. VAN. Electric generator lamps. (21/9/17.) 109,826.
13,488 RELAY AUTOMATIC TELEPHONE CO. & JOHNSON, B. B. Automatic telephone systems. (22/9/16.) 109,829.
13,489 RELAY AUTOMATIC TELEPHONE CO., WARD, F. M., BYGRAVE, L. C. & HERINK, H. J. Automatic telephone systems. (22/9/16.) (Patent of Addition not granted.) 109,830.
13,725 SCOTT, J. Combined switch and plug boxes for electric circuits. (27/9/16.) 109,842.
13,812 BACHELET, E. Electro-magnetic engine. (28/9/16.) 109,847.
14,629 HALLIMOND, A. F. & FLETCHER, W. G. Magnetic separators. (14/10/16.) (Cognate application, 5,054/17.) 109,857.
14,658 WHITAKER. Protection of electric cables. (16/10/16.) 109,679.
15,359 HEARN. Electric heating element for kindling. (27/10/16.) (Addition to 4,600/15.) 109,684.
15,607 BAKER, H. H. Electric fuses. (1/11/16.) 109,867.
15,692 LIEBMANN, A. J., Compositions of matter, and processes of making same. (2/11/16.) 109,870.
Consists of a mixture of carbon, copper and a highly refractory metal such as metallic tungsten, molybdenum, titanium, or the like, for use in electrodes and brushes for dynamos and electric motors.
15,781 B.T.-H. CO. (General Electric Co.) Protective devices for electric circuits. (4/11/16.) 109,871.
16,695 GREEN, H. Electric signalling. (22/11/16.) 109,886.
16,814 FENETY. Means for attaching lamps to electric wiring. (14/12/15.) 102,719.
16,969 STERLING TELEPHONE & ELECTRIC CO. & BELL, F. G. Electrically operated bells. (27/11/16.) 109,889.
17,011 JAMES, H. V. Controlling apparatus for electric motors. (27/11/16.) 109,890.
[illegible]
Comprises a soft iron member continuously under the influence of one pole of a permanent magnet, said soft iron member being open at one end and forming two inwardly extending arms in the gap between which the armature is adapted to lie, and having a transversely disposed part extending in position between the arms to serve as the core of an electromagnet, which on being energised imparts opposite [illegible]
[illegible] les. (21/1/16.) 103,643.
18,460 COLLEY, R. J. DAVIES. Portable electric hoisting gear for discharging baskets from ships, and for analogous purposes. (27/12/16.) 109,904.
18,609 PINNOCK. Electric warming apparatus. (29/12/16.) 109,719.

[illegible]

6,952 AKT. GES. BROWN, BOVERI ET CIE. Conversion of electric currents by means [illegible] tifiers fed with polyphase currents. (18/5/16.) 106,999.
Electrical connection for using the full extent of the positive half of the voltage [illegible]

APPLICATIONS FOR PATENTS.

[illegible] of inventions. When complete Specification accompanies application an asterisk is affixed.

[illegible]

September 28, 1917.

[illegible]

September 29, 1917.

14,071 GERBER. Electric illuminating device for telescope, &c., sights of machine guns
14,078 TWIDELL. Tilting trunnion combined with roller chain for electric tilting furnaces, &c.
14,092 VANDERVELL & MIDGLEY. Electrical gyroscopes.
14,096 SIEMENS & HALSKE A.G. Photometry. (12/1/17, Germany.)
14,097 WILLCOCKS. Sparking plugs.

October 1, 1917.

14,107 STEWART. Locking electrical spigot and socket unions. (10/11/16, Australia.)
14,120 TAYLOR. Insulators for telephone, &c., wires.
14,165 LATOUR. Audion or lamp relay or amplifying apparatus for wireless telegraphy &c. (30/9/16, France.)
14,169 FENGE. Preventing dead lines at crossings or junctions on electric tramways.
14,171 GREAVES. Thermostatic circuit closers.

October 2, 1917.

14,181 COWDERAY. Apparatus for use with searchlights.
14,187 RAILING & TAYLOR. Electric hand lamps.
14,194 POPPER. Electrolytic process to recover metal from scraps.
14,197 BIJUR. Electrical apparatus for internal combustion engines. (24/11/15, U.S.)
14,201 WOODBURN. Electric welding apparatus.
14,210 JAMES. Automatic control of electrically operated feed reel brakes.
14,215 B. T.-H. CO. (G. E. CO.) Electric furnace control apparatus.
14,232 CIE. GENERALE D'ELECTRICITE. Steam turbines. (14/11/16, France.)
14,254 DIXON. Telegraph, &c., signalling systems.

October 3, 1917.

14,286 LOCKWOOD. Electro deposition of metals.
14,309 FULLER ACCUMULATOR CO. & WOOD. Electric storage batteries.

October 4, 1917.

14,335 BURNETT. Depositing chromium electrolytically from its chemical salts.
14,336 BURNETT. Chemically depositing chromium upon metals other than by electrolysis from the salts of chromium.
14,338 BANNISTER & STANNARD. Treatment of wolfram ores.
14,341 PARKER. Fusible metal, &c., cores or mandrels for electro-deposited metal tubes, &c.
14,348 BROWN & CHILD. Magnetic separation of metals or magnetic bodies from oil flowing through oil circuits.
14,350 B. T.-H. CO. (G. E. CO.) Electric transforming and converting apparatus.
14,360 GUNSTONE & PEARCE. High frequency spark.
14,361 GUNSTONE & PEARCE. Rectifier for mercury interrupters.
14,369 TANNER. Electric motors. (19/7/16, U.S.)
14,373 CLOAKE. Pocket flash lamps.

October 5, 1917.

14,392 LAMPLOUGH RADIATOR & ENGINEERING CO. Fusible mandrels for copper, &c., deposited tubes.
14,393 GOLDSTONE. Incandescent lamp holders.
14,399 CUSHION. Electric torch apparatus.
14,402 BOUDREAU & VILBISS. Spark plugs. (2/6/17, U.S.)
14,411 SIEMENS-SCHUCKERTWERKE. Electrical transformers, &c. (2/12/16, Germany.)
14,419 B. T.-H. CO. (G. E. CO.) Fluid flow meters.
14,424 MORRIS. Detecting variation in magnetic fields.
14,430 A. G. BROWN, BOVERI ET CIE. Magneto-electric ignition apparatus. (31/10/16, Germany.)
14,437 PEARSON. Electric primary cells.
14,446 SUBMERSIBLE & J. L. MOTORS & DURNFORD. Electric motors.
14,451 SUBMERSIBLE & J. L. MOTORS & DURNFORD. Dynamo electric machines.

October 6, 1917.

14,455 ELECTRIC PULLEY BLOCK CO. & SMITH. Electric pulley blocks.
14,458 GOLDSTONE. Electro-medical coils.
14,481 COURTIER. Sparking plugs.
14,484 INGER. Material for electric resistances, &c.
14,493 GURNEY. Incandescent electric lamps and lamp holders.

October 8, 1917.

14,538 YOUNG. Machine for generation of electric currents.
14,557 WITHERS. (Hart & Hegeman Mfg. Co.) Electric snap switches.
14,560 REMY ELECTRIC CO. Circuit breakers for ignition apparatus. (10/11/16, U.S.)
14,561 LANCASHIRE DYNAMO & MOTOR CO. & WHITMORE. Magnet coil windings.

October 9, 1917.

14,582 B. T.-H. CO. (G. E. CO.) Thermo regulators and alarms.
14,588 ROSS, COURTNEY & CO. Tools for clinching electric terminals.
14,597 B. T.-H. CO. (G. E. CO.) Signalling systems.
14,598 WALL. Alternating-current generators.
14,613 ISENTHAL. Rheostat or resistance indicators for switchboards, &c.
14,622 FESSENDEN. Detecting low frequency impulses. (21/5/17, U.S.)
14,626 FESSENDEN. Detection of submarine impulses. (29/3/17, U.S.)

October 10, 1917.

14,652 B. T.-H. CO. (G. E. CO.) Amplification of small currents.
14,653 B. T.-H. CO. (G. E. CO.) Leading in wires for incandescent lamps, &c.
14,654 ILLINGWORTH. Electrical circuit breaker.
14,664 LEMERCIER. Electrically heated clothing for aviators, &c.

October 11, 1917.

14,697 ROLLASON. Impregnation of water, &c., with radio-active emanations and gases.
14,723 B. T.-H. CO. (G. E. CO.) Electric switches.
14,727 CHITTY. Dynamo-electric machines.
14,738 KENNETT. Portable transformers in electrical circuits.
14,742 SMITH. Fitting safety fuses.
[illegible]
14,749 COWPER-COLES. Apparatus for electro-deposition.
14,750 SUBMERSIBLE & J. L. MOTORS & DURNFORD. Coupling devices for electric cables.

VOLUNTEER NOTICES.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

Headquarters, Balderton-street, Oxford-street, W. 1.

Lieut.-Colonel C. B. CLAY, V.D., Commanding.

Orders for the Week.

Officer for the Week: Second Lieut. E. A. Ullmann.

[illegible] Saturday, November 17, 1917.

Monday.—No. [illegible] Company, Left Half, Recruits, Signalling, 6.30.

Tuesday.—[illegible] Drill and Bayonet Exercise, 7.30.

Wednesday.—No. [illegible] Company, 6.30.

Thursday.—No. 2 Company, 6.0 Signalling, Ambulance, 6.30.

Friday.—No. 3 Company, Right Half, Recruits, 6.30.

Saturday.—[illegible] N.C.O.s and men in Sections A, B and C by a [illegible] Officer [illegible]. All N.C.O.s and men in these sections are [illegible] at headquarters at 2.30 p.m. Uniform.

Note.—The [illegible] Officer will attend for examination of recruits, &c. on [illegible]

All [illegible] must be returned to the Q.M. Sergeant [illegible]. Unless otherwise indicated, all drills will take place at headquarters.

COMMERCIAL & INDUSTRIAL SECTION.

Tin and Tungsten Research.

An announcement, issued through the Press Bureau, states that one of the most attractive fields for investigation that are being opened by the exigencies of the war is that which pertains to the winning of tin and tungsten.

Recently some successful experiments have been made with a view to increasing the recovery of tin. No systematic researches, however, have been undertaken beyond those designed to improve the appliances now in use; and, having regard to this fact, the Privy Council Committee for Scientific and Industrial Research has expressed the hope that a Research Association might be established, in order that the series of investigations already undertaken might be continued on a larger scale. One of the difficulties in the way hitherto has been the want of adequate funds for sustained investigation and experimental trials. But the Ministry of Munitions suggests that those interested in the tin and tungsten mines of Cornwall and Devon should co-operate in the establishment of a Research Association and contribute to a central fund devoted to a study of the many-sided aspects of the problem. In this way adequate means might be provided annually for two or three years, and with such a fund, supplemented, if necessary, by a grant from the Committee of the Privy Council, experimental researches upon scientific principles could be conducted under the continuous supervision of first-class professional men. Under present methods over 35 per cent. of tin and a higher percentage of wolfram in the ore is lost. A conference for the consideration of the proposals of the Ministry was held on Wednesday.

* * * *

The Iron and Steel Trades and Government Control.

At a well attended meeting of merchants engaged in the iron, steel and metal trades on the North-East Coast on the 1st inst. it was decided, in view of the difficulties in carrying on their business owing to Government restrictions, to form an association for mutual protection.

Col. Sir JOHNSTON WALLACE, who presided, said that the merchants of this country had been referred to as parasites on industry, and he contended that their methods were strictly honourable. There was no intention of hindering the Government in the prosecution of the war, but the merchants claimed the right to carry on their business without undue and unnecessary control.

Mr. J. GRAY BUCHANAN, chairman of the Iron and Steel Merchants' Section of the London Chamber of Commerce, said the merchants had no objection to the Government controlling trade, but they objected to the way in which that control was exercised. The Government consulted the manufacturers, but ignored the merchants, whose knowledge and experience was invaluable. There was a great danger that the confidential information which had been given freely to the Ministry of Munitions might be used afterwards to the detriment of the merchants.

Mr. R. M. RICHARDSON warned the Government that any attempt to eliminate the merchant, and prevent him employing his capital, and carrying on his ordinary business after the war, would be attended with grave consequences to the community at large, besides proving a valuable asset to the enemy in his efforts to recapture trade in the world's markets.

The resolution to form a local association of merchants was carried unanimously, and a committee was appointed to make arrangements.

* * * *

Excess Profits Decisions.

The "Financial Times" publishes a summary of the decisions of the Board of Referees regarding increases in the percentage rates for excess profits under sec. 12 of the Finance (No. 2) Act, 1915.

The following are amongst the percentages mentioned for limited liability companies and for other businesses respectively:—Electric cable manufacture, 7 and 8; hydro-electric power in the Transvaal, 9 and 10; electric light and power at [illegible], 9 and 10; electric supply in India 7 and 8, in London 7 and 8, in the provinces [illegible]; [illegible] in New Zealand [illegible]; [illegible] in Shanghai 9 and 10, in Cape Colony, [illegible]; manufacture of electrical machinery, [illegible]; [illegible] in Bengal, 10 and 11; [illegible] 8 and 9; motor manufacture [illegible] New Caledonia, 8 and 9; [illegible] 10 and 11; [illegible] tramways and light railways [illegible]; [illegible] 12 and 13.

In the "London Gazette" [illegible].

* * * *

Ball Bearings.

By an order, dated Nov. 1, the Minister of Munitions has directed that no person shall manufacture any ball bearing or roller bearing or any part thereof except in accordance with the terms of a licence issued under his authority.

No person shall until further notice sell, supply or deliver any ball bearing or any part thereof whether situated in or outside the United Kingdom, or purchase or negotiate for the purchase or take delivery of any ball bearing or any part thereof.

All persons engaged in the manufacture or sale of ball bearings shall make such returns with regard to their businesses as shall from time to time be required by or under the authority of the Minister of Munitions. All applications should be addressed to the Director of Ball Bearings, T.M.3, Ministry of Munitions, Whitehall place, London, S.W. 1.

* * * *

Water Power in Canada.

Recent investigations by the Water Power Branch of the Canadian Department of the Interior show that the Great Saskatchewan River and its tributaries (which drain the southern portion of the Provinces of Alberta and Saskatchewan) and the Winnipeg River and other streams flowing into Lake Winnipeg can give enough water power to generate at least 1,172,000 H.P. of electrical energy. In the Athabasca, Peace, Churchill and other large rivers which drain the northerly portion of the three Provinces, there is sufficient water power to give 5,465,000 H.P. of electrical energy.

Up to the present 12 plants have been established and only 109,000 H.P. is actually being utilised, of which 107,000 H.P. is developed by four plants. Two of these plants are on the Winnipeg River, and belong to the Winnipeg Electric Railway and the Municipal Railway respectively, and two are on the Bow River at Kananaskis, 50 miles west of the city of Calgary, where 31,000 H.P. is developed and used mainly in lighting the city, running its street cars and supplying motive power at cheap rates to its industries. There is sufficient water-power in the Winnipeg River to produce, eventually, as great a volume of hydro-electric power as is now taken from Niagara Falls, and there is sufficient in the Bow River basin, supplemented by storage capacity, to create 93,000 H.P., all within easy transmission reach of Calgary.

* * * *

Parliamentary Representation for the Metal Industry.

A meeting was recently held in Birmingham in support of the formation of a federation of British [illegible] who are engaged in the iron and steel, [illegible] and metal trades. The "Birmingham Post" thinks the meeting [illegible] towards the [illegible] of a movement for establishing [illegible] Iron and Steel Committee of members of the House of Commons, a project from which, at its inception 11 years ago, [illegible] and collecting information [illegible].

[illegible] construction of all kinds of machinery [illegible] that outlined above would [illegible].

* * * *

Supply of Building Materials.

[illegible]

ELECTRICITY SUPPLY.

EXTENSIONS.

Barrow-in-Furness.—Sanction has been received to borrow £10,575 for boiler foundations, steam pipes, &c., and for sub-station plant and switchgear, and a sum of £5,325 for mains extensions.

Bootle.—In view of the increasing demand for electrical energy for power, it is proposed to form a special committee to consider and report upon a scheme of extensions for the electric supply undertaking.

Bradford.—Last week the Corporation accepted a tender for the supply of a 12,000 kw. Parsons turbo-alternator at £45,775.

The chairman of the Electricity Committee (Ald. Robinson) said that the matter had been before the Council since June 1916, and it was not until Aug. 21 last that they got permission from the Ministry of Munitions to put in the new machinery which was necessary, because the plant at Valley-road was fully loaded. The peak load for some time last month had been 18,000 kw. They had practically no spares, and it was very important that they should put in the plant as soon as possible.

The Committee had once more brought forward the proposal for increasing the charges for electricity. The Council had referred the proposed increases back to the last meeting, but since then there had been another increase in the price of coal of 2s. 6d. per ton, and if something was not done to meet increased costs their accounts would next year show a balance on the wrong side of the ledger.

After discussion, the suggestion was made that the Council should accept the new charges, but that they should not come into operation until April 1 next year.

Ald. Robinson accepted this compromise and the minutes were then approved.

Durham.—Whickham Urban Council has approved the plans of the County of Durham Electric Power Supply Co. for laying a h.-t. transmission cable from Dunstan to the district boundary at Squarebridge, Swalwell.

Kilmarnock.—The Scottish Office has sanctioned the borrowing of £61,000 for extensions of the electricity works.

Leicester.—As stated in our last issue the Corporation have unanimously adopted the proposal to acquire a site for a new generating station.

Ald. FLINT, in moving the adoption of the scheme of the Tramways and Electricity Committee, said that they were now working at the full capacity of both their generating stations. There were applications in hand for 800 kw., and other applications were coming in. It was thought there would be an increased demand in future, in advance of pre-war time, and the supply of electricity for power had grown from 63,000 units in 1908 to 9,000,000 in 1916. The committee had reviewed the entire position, and thought it would be a satisfaction to have expert advice. The services of Mr. C. H. Wordingham, president of the Institution of Electrical Engineers, had been obtained, and he was of the opinion that, looking to the future, it was essential they should have a large central station, and that the present sites were not capable of extension to meet the probable demands of the future. With regard to the site recommended by Mr. Wordingham they had tried to secure an option of purchase at a certain price, but they had not agreed upon the price, and negotiations were still proceeding. Although they were looking to requirements for some distance ahead, their intention was not to commit the Corporation to unnecessary expenditure at an early date, either for buildings or plant, but to move in stages. There were outside interests wanting to come into Leicester, and if the Corporation failed to meet the demand for electricity they would get in.

Mr. C. H. WORDINGHAM, who was invited to address the Council, said the war had had a great influence on the electricity supply. There was a very much larger demand, and which, no doubt, would diminish so far as it related to war purposes at the end of the war, but he thought the demand would be at least as great for those industries which would take the place of the manufacture of munitions. The use of electric power had brought home as nothing else could have done the [illegible] advantages of electrical driving; therefore, he thought the demand would not diminish after the war, but would, on the contrary, [illegible]. The need for economy had been brought home to the [illegible]. Electric power supply was one means of economising [illegible]. The greatest economy of fuel would be gained by [illegible] [illegible]

modern lines, they would have one of those large stations and would be in a position to make favourable terms for linking up with other large stations. Smaller stations would not have any chance whatever of joining up in a large scheme for covering the whole country. A large station and a consequent cheap supply would be likely to attract industries to Leicester.

After discussion the motion was unanimously agreed to.

GENERAL.

Ballyconnell.—The local electric light and power company has entered into a contract with Bawnboy Rural Council for the electric lighting of Ballyconnell for the season.

Carlisle.—The employees of the electricity and gas departments recently asked that the existing war bonuses should be counted as wages, and that an advance of 5s. per week be also granted.

The Wages Committee has declined to accede to the request that the war bonuses be counted as wages, but recommended that in determining the rate of pay for overtime the bonus be included.

This has been confirmed by the Council, and the question of the 5s. advance in wages has been deferred for three months.

Cleckheaton.—Arrangements have been made with the Yorkshire Electric Power Co. for a supplementary supply of electricity in bulk.

Edinburgh.—The annual inspection of the municipal electricity supply stations took place on the 1st inst., and subsequently the convener (Councillor Bruce Lindsay) and the members of the Electric Light Committee visited the M'Donald-road station, where the engineer (Mr. F. A. Newington) explained the recent developments.

Afterwards the Committee visited the sub-station at the North British Rubber Co.'s works, where the new transformers and switchgear were inspected.

In the evening the convener entertained the members of the Committee, the Corporation officials, &c., to dinner in the Caledonian Station Hotel. In the course of a statement on the progress of the electricity department, Mr. Bruce Lindsay stated that the consumption of electric lighting units for the year ending May last was 8,651,300, a decrease of 96 per cent. The power units were 9,051,000 units, an increase of 25 per cent. The public lighting represented 176,100 units, a decrease of 62 per cent., accounted for by the restriction of public lighting. Traction represented 118,000 units, a decrease of 4 per cent. The units sold for power were more than the units sold for lighting for the first time in the history of the undertaking. Since May, 1912, the units for power were nearly doubled. The total horse-power of the motors connected was now 19,285. The total capacity of their stations was 20,210 kw., but looking at it from the point of boiler power it was only 16,000 kw. They asked permission to have two of the new boilers for Portobello station worked temporarily at M'Donald-road, but that was refused. In the winter of 1913-14 the load was 12,500 kw. If there were no lighting restrictions they would be running at a load of 15,540 k.w. So that they were running dangerously near their possible capacity. The North British Railway Co. were at present taking from 6,000 to 7,000 kw. They had an engine which might give way at any time. To replace that engine they would require 2,000 kw. to 3,000 kw.

In regard to future developments, they were extremely anxious as to the construction of the new station at Portobello. They meant in the next few days to send a further communication to the Board of Trade on that subject. That was altogether outside the question of what electric power might be required for tramways. They knew that in the course of the next two or three years there might be a large requirement for electric power for tramways. Without the Portobello station they could give nothing. With regard to their own municipal work, it appeared to him that horse-power would be displaced by electric power. In the cleansing department, for instance, he was quite satisfied the internal combustion engine, the petrol engine, was not suitable. There was far too much stopping and starting with the petrol engine. Corporations in England, as well as Glasgow Corporation, had been going in for wagons propelled by electric power. He anticipated there would be a large extension of the use of electric current in that way. Industrial extension depended mainly on cheap electric power. They could extend industrially in Edinburgh to any extent without prejudicing the amenity of the city. With electric power they would have no chimney stacks or smoke, and they would have abundance of power at a low cost. They were most happily placed with regard to the officials in the electricity department, particularly with regard to Mr. Newington, Mr. Seddon, his second in command, and Mr. Robertson, who was in charge at M'Donald road. In the near future they were likely to have very strenuous times. Mr. Bruce Lindsay concluded by proposing the health of the officials, to which Mr. Newington replied.

The Committee recommends the Council to increase the charge for current for domestic lighting by ½d. per unit, in view of the increase in the price of coal.

Electricity in Agriculture.—The Committee of the Municipal Electrical Association on the development of electricity in agricultural areas is originally constituted of the Municipal Electrical Engineers of Bristol (Mr. H. Faraday Proctor), Norwich (Mr. F. M. Long), Hereford (Mr. W. T. Kerr), Wolverhampton (Mr. S. T. Allen).

Chester (Mr. S. E. Britton) and Ipswich (Mr. F. Ayton) has now been enlarged by the inclusion of the following co-opted members: Lord Tollemache, Commander P. N. Bircham and Prof. Jorgensen, together with Mr. C. T. Allen, representing the Incorporated Association of Electric Power Companies, and Mr. C. W. Langford, representing the National Farmers' Union.

Electric Power Supply Committee.—At the recent quarterly meeting of the Executive Council of the Urban District Councils Association a report was submitted by the sub-committee appointed to prepare and consider the evidence to be given on behalf of the association before the Board of Trade Electric Power Supply Committee.

It appeared that Mr. W. P. Nicholas, of Rhondda, had been appointed to give evidence and to state the case on behalf of the association, and that Mr. A. H. Dykes (of Messrs. Handcock, Dykes & Trotter) had also been consulted as to the evidence. The sittings of the committee being private, no proof of the evidence is available.

Gillingham.—The Council has rejected a recommendation of the Electricity Committee to increase the price of electric current by a further 10 per cent. The deficit on the undertaking will, therefore, be met out of the rates.

Glasgow.—As the engineer and general manager of the electricity department (Mr. W. W. Lackie) has reported to the Electricity Committee that the higher price of coal would entail an additional expenditure on fuel for the current year of about £25,000, the committee has been authorised to increase the charges for electric energy for all purposes by 0·075d. per unit.

Hebden Bridge.—The Council recently made arrangements with Halifax Corporation for the supply of electricity in bulk, and the distribution sub-station is nearly ready for giving a supply.

Increased Charges for Electrical Energy.—The charges for current are being increased at the following places:

Leek Council has decided to increase its charges for energy for power purposes by 10 per cent.

At Salford the existing charges for electricity are to be increased from 10 to 20 per cent. for lighting and from 15 to 30 per cent. for power, from Dec. 1.

Southampton Corporation is increasing its charges by 10 per cent.

Glasgow Corporation is increasing its charges for current by 0·075d. per unit.

Burnley Electricity Committee recommend increases of 0·12d. per unit for current, power and traction and ½d. for lighting.

Burton Corporation is increasing its charges by 10 per cent., both for lighting and power.

At Todmorden the charges have been increased 10 per cent., with a flat rate of 5d.

Accrington Corporation charges are being increased as follows: 10 per cent. to consumers on the rateable value system or using current for heating, 10 per cent. to power users not affected by coal sliding scale, and [illegible] per unit to power users under agreement.

Falkirk Council has decided to increase its charges for current for lighting by ½d. per unit and for power by 0·075d. per unit.

Islington (London).—The special Committee on Wages reports that the Committee on Production has decided that the various increases of wages granted by the Council to men employed in the electricity department should not be taken into account by the Council in the computation of the increased war wages of 12s. per week recently awarded by the Committee.

[illegible]

Rotherham.—[illegible]

Shipley.—[illegible]

Spenborough.—[illegible]

Stepney (London).—At the Council meeting to-day (Friday), the Finance and Parliamentary Committee will submit a report in reference to a loan of £15,000 borrowed for the electricity department from the Derbyshire Miners' Association, at 4 per cent. interest, in accordance with authority on June 29, 1915.

The Electricity Supply Committee has received from the association [illegible]

Todmorden.—The electrical engineer (Mr. J. Boyce) recently inquired whether Burnley Corporation were prepared to enter into negotiations for the supply of electricity in bulk, but the Electricity Committee has decided that the proposal is not feasible at present.

West Ham.—The Electric Lighting Committee recommend that the undermentioned officers be granted an increase of 15 per cent. on their pre-war salaries as under (less any merit increases granted since the commencement of the war), to date from the 1st ult.

Mr. J. Allan, station superintendent; [illegible] Mr. W. A. Gilbett, [illegible] manager and meter superintendent; Mr. G. Smith, departmental accounts clerk; Mr. H. B. Johnson, chief clerk; Mr. E. Tombs, stores manager; Mr. G. D. Bendix, assistant station superintendent; Mr. W. Whitney, assistant mains engineer; Mr. W. S. Cobb, station foreman.

It is further recommended that [illegible] to Mr. R. Snell, assistant meter superintendent, and to Mr. H. B. Irons, installation inspector.

Workhouse Lighting.—[illegible] spend £400 on repairs and improvements in the electric lighting plant.

Wrexham.—The salary of the assistant electrical engineer (Mr. S. Thornton) has been increased to [illegible] per annum.

ELECTRIC TRACTION.

Bradford.—Recently the tramway workers applied for an advance of £1 per week on the pre-war rate of wages, and now the women employes of the Corporation have applied for the equal terms with the men.

The Council are recommended to allow the overhead staff in the tramways department a fortnight's [illegible] instead of a week, as at present.

Edinburgh.—[illegible]

Edinburgh.—In regard to the proposal of the Council to construct an electric tramway to Queensferry the Admiralty state that they would prefer the line to be [illegible]

The Admiralty [illegible] past Dalmeny, and that a line should be run down to Hawes Pier.

[illegible]

Electric Vehicles for Refuse Collection.—In the report of the Sheffield Corporation Cleansing Department for the past year the superintendent (Mr. J. A. Priestley) states that three additional electric vehicles were put into service during the year, and orders placed for five more. Further experience with these vehicles has confirmed the favourable opinions expressed last year as to their value in refuse collection work; in fact, the Health Committee express the view that, had it not been for their use, the work of the department must have become hopelessly in arrears.

"The results of the year's working show conclusively that by the use of electrics the work can be done more effectively, economically, and with less workmen than by horses. In comparison with the average cost by horse labour over the whole city, the electrics show a saving on bin-refuse collection of 8·8d. per ton, and on ashpit refuse of 1s. 7·2d. per ton. There is little doubt that it is to electricity as a motive power for transport vehicles engaged in town collection and delivery work that the future must look for a solution of many of the present-day difficulties." Garage accommodation has been provided at Worthing-road and Penistone-road depots, and charging facilities arranged which will suffice for a considerably increased fleet of vehicles.

London United Tramways.—The directors of this Company have intimated to the Councils of the districts through which the lines pass that it is proposed to promote a Parliamentary Bill for relieving the Company from the restrictions imposed upon it with regard to fares, and also for power to abandon portions of its lines in Middlesex and Surrey.

Tramway Workers' Wages.—The Committee on Production have awarded an advance of 5s. a week in the wages of all drivers and conductors and the inside staffs of the Metropolitan Electric Tramways, the South Metropolitan Electric Railways & Lighting Co., and the London United Tramways.

IMPERIAL NOTES.

Australian Exports Restriction.—A list has been prepared by the Commonwealth Department of Trade and Customs specifying the articles for the exportation of which a Customs permit must be obtained.

The list includes hydrochloric, muriatic, nitric, sulphur dioxide, sulphuric and sulphurous acids; alloys (metals); alumdum, natural and artificial; aluminium and its alloys; aluminia and salts of aluminium salts (anhydrous), &c.; antimony and antimony ores; antimony sulphides and oxides; asbestos, asphalt, bauxite, bitumen, brass, cadmium and cadmium alloys and ores, calcium acetate, nitrate and calcium carbide, carbides of all kinds, carbons for searchlights, all abrasive materials, caustic potash and soda, celluloid, chrome ore and ferrochrome, chronometers, metal concentrates, copper pyrites and other copper ores, copper (unwrought and part wrought), copper wire, alloys and compounds of copper; electric appliances adapted for use in war and parts, internal combustion engines and lorries capable of carrying 25 cwt. and upwards, ferro-tungsten, ferro-molybdenum, ferro-chrome, ferro-manganese, ferro-vanadium and ferro-silicon; graphite for crucible manufacture, iridium iron (electrolytic), iron ore and pyrites., lead and lead ore, leather belting [illegible] magnesium and magnesite, manganese and manganese ore manganese oxides, mercury, metals, alloys and minerals of all kinds, metallic sulphites and thio-sulphates, mica, mineral oils, molybdenum and [illegible] motor vehicles of all kinds, vanadium, vessels, [illegible] of all kinds, wagons (four wheeled) capable of carrying [illegible] telegraph material, wolframite, zinc ore, zinc [illegible] and compounds thereof, and all goods for Norway, Sweden, Denmark, Netherlands, Switzerland and Greece.

Australasia.—The "Australian Mining Standard" says the town [illegible] in the Wimmera district of Victoria is to be lighted electrically, and a Melbourne firm has been asked to furnish an estimate [illegible]

[illegible] Factories (Amendment) Act of 1908 [illegible] after the war there may be more oppor[illegible]

India.—At a recent meeting the Rangoon Municipal Committee decided not to enter into a fresh agreement with the Rangoon Electric Tramway Co. for the public lighting of Rangoon but the [illegible] Committee is to consider the whole question.

New Zealand.—The New Zealand Minister of Finance, in his recent budget statement for the year ended March, states that it is proposed to abolish the excess profits tax, and he has asked for [illegible] additional taxation on land and income. [illegible] £3,000,000.

Quebec Mining Industry.—The annual report of the Mines Branch of the Quebec Provincial Department of Colonisation, Mines and Fisheries shows that the mineral production for the year amounted to £2,657,404, an increase of nearly £40,000 over 1913, hitherto the record year.

The increase is wholly attributed to the products of the mines proper, such as asbestos, copper, chromite, magnesite, molybdenite, mica, zinc and lead. The report gives a full account of the results of an investigation of the mineral resources along the line of the Transcontinental Railway between Hervey Junction and Doucet.

FOREIGN NOTES.

Argentina.—The "Review" of the River Plate says the municipality of Tucuman were recently notified by the local electric lighting company that the supply of current for public lighting would have to be suspended unless the municipality paid the company's account, which at that time amounted to $228,332.

Exemption from import duty has been granted in respect of building materials (not produced in Argentina) for the municipal power house at Villaguay (Entre Rios Province).

Maracaibo (Venezuela).—It is stated that the Maracaibo Electric Light Co., which commenced the supply of current in 1888, is now furnishing electricity during the 24 hours during the day time.

The capacity of the plant has been increased fourfold during the last two years, and the company has also introduced the United States standard 3-phase, 60-cycle system, with standard voltages. An American is the chief engineer for the plant. In view of the fact that electric power is now being furnished during the day, there should be good opportunity for the sale of electric motors, heating and cooking apparatus, fans, &c.

Peat Utilisation in Germany.—The large peat utilisation works at Elizabeth-Fehn, Oldenburg, has found that 300 tons of peat will yield 90 tons of peat coke, in addition to the by-products of gas and tar, which are now almost invaluable.

The peat is collected by dredgers, which are electrically driven, part of the gas obtained during the coal distillation being used to drive electric generating plant, and part of the gas is also used to heat the ovens.

Sweden.—The Stockholm Waterfall Board has asked the Swedish Government for a grant of 4,000,000 kronor (£222,222, at par rate), of which 3,000,000 kronor are required for the power station on the Lulea River, and 1,000,000 kronor for regulating the water supply in certain lakes.

MISCELLANEOUS.

British Industries Fair.—The Board of Trade are again organising a British Industries Fair, which will be held in London from Feb. 25 to March 9, 1918.

Forms of application for space are now being issued to manufacturers in the china and earthenware, glass, fancy goods, paper, printing and stationery, and toy and games trades. The Board, by the courtesy of the Port of London Authority, who have recognised the importance of the Board's securing a larger building than those hitherto used, have been fortunate to obtain the use of a most suitable building for the purpose. Applications for space should be sent to the Director, British Industries Fair, 10, Basinghall-street, E.C. 2.

Electricians' Wages.—On the suggestion of the Chief Industrial Commissioner (Sir Geo. Askwith), a conference of local authorities owning electricity works is to be held to consider the question of uniform payment and conditions of service for electricians at power stations, and to consider the wages of semi skilled and unskilled men at such stations owned by local authorities in the greater metropolitan area.

Enemy Firm Wound Up.—The Controller of the Mea Magneto Co. Ltd., has applied for a release. Objections to the Board of Trade before Nov. 14.

Engineers' Wages.—The Committee on Production has made an award giving a further advance of wages to all grades of workmen employed by members of the Engineering Employers' Federation.

The award is given in pursuance of an agreement between the federation and 18 trade unions connected with the engineering and foundry trades, under the terms of which the Committee on Production may be called upon at intervals of four months to consider what alteration in wages is warranted by the abnormal conditions due to the war. The previous awards of the Committee were made on March 1 and July 11, and the effect of the award, in conjunction with previous awards, was to establish for the engineering and foundry trades a general advance as compared with pre-war rates of not less than 15s. per week on time rates. The award now issued gives a further advance of 5s. per week, making the aggregate increase on pre-war rates 20s. per week.

The claims put forward by the unions representing the skilled trades were for an increase of 100 per cent on the wage rates obtaining in July, 1914, less the advances which have already been given during the war. The unions representing semi-skilled and unskilled labour applied for an increase of 10s. per week to men and 5s. per week to boys under 18 years of age, with an equivalent advance to pieceworkers; these unions claimed also a minimum rate of 50s. per week for labourers.

Under the award made by the Committee, men of 18 years and over will receive 5s. per full ordinary week. Boys and youths and apprentices under 18 years of age will be paid 2s. 6d. per full ordinary week, and boys, youths and apprentices on attaining the age of 18 will receive a further 2s. 6d. In the case of pieceworkers, premium bonus workers and other men working on systems of payment by results, the amount is to be paid by the firms at the rate of 5s. per full ordinary week over and above the week's earnings of the men concerned, calculated on the present basis. The advances are to be paid as from the beginning of the first full pay in December. The amounts awarded are to be regarded as war advances, intended to assist in meeting the increased cost of living.

Applications for special advances in certain districts are still under consideration by the Committee.

Winter's Pie, 1917.—We are glad to hear that that ever-welcome annual, "Winter's Pie," will be published on the 12th inst., and, judging by the list of eminent authors and artists who have contributed to its pages, it will undoubtedly come as a cheery gleam to those on active service, in hospitals and camps, or at home.

The price will not be increased; it is wonderful value for 1s. "Winter's Pie" is published at 6, Great New-street, London, E.C., and is obtainable at all booksellers and bookstalls, 1s. net.

TENDERS INVITED AND ACCEPTED.

Train Lighting Cells.

Tenders will be received by the Tender Board, SOUTH AFRICAN RAILWAYS, Johannesburg, until noon, Nov. 12, for the supply of 4,466 train lighting cells.

Railway and Tramway Stores.

BRADFORD Tramways Committee require tenders by Nov. 24 for 12 months' supply of stores, including controller fingers, contacts, &c., ironmongery, bolts, nuts and screws, insulating material and tapes, iron and steel, pinions, vulcanite, castings, oils, &c. Forms of tender can be obtained at the Tramway Offices, 7, Hall Ings, Bradford.

The GREAT NORTH OF SCOTLAND RAILWAY Co. require tenders by 10 a.m., Nov. 22, for six or 12 months' supply of stores and materials, including telegraph material, boiler tubes, steel, castings, ironmongery, oils, &c. Forms of tender from Stores Superintendent.

Tenders are required by CHESHIRE LINES COMMITTEE by 10 a.m. Nov. 22 for one year's supply of stores, including telegraph materials, carbons, oils, paints, &c. Specifications from the Stores Superintendent, Warrington.

THE SLIGO, LEITRIM AND NORTHERN COUNTIES RAILWAY Co. require tenders by 10 a.m. Dec. 1 for 12 months' supply of stores, including telegraph materials, rubber goods, brass, copper, zinc, tools, wire, &c. Forms of tender from the Secretary, Enniskillen.

MANCHESTER Tramways Committee require tenders by 10 a.m. Nov. 13 for the supply of h.d. copper trolley wire. Specifications and forms of tender from the General Manager.

Telephone Material.

The Deputy Postmaster-General, Perth (W. Australia), requires tenders by 3 p.m. Dec. 5 for supply of telegraph and telephone instruments and parts, and materials for batteries (Schedule 583, W.A.) and by 3 p.m. Dec. 12 for telephone switchboard parts (Schedule 582, W.A.), for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

GLASGOW.—An order has been placed with Johnson, Park & Co. at £9,188, for electric lighting and power plant at the Robroyston Hospital.

HALIFAX.—The Gas Committee has placed an order with W. T. Glover & Co. for the electric wiring required for the clinker hoists, coke elevating plant, &c., at the [illegible], at £263 [illegible].

MARYLEBONE (LONDON).—At [illegible] Council meeting the Electric Supply Committee [illegible] that the contract of British Insulated & Helsby Cables [illegible] be extended for a further six months, at 10 per cent. [illegible] upon the prices [illegible] in the contract [illegible] adopted.

[illegible].—The Corporation [illegible] accepted the tender of the [illegible] for the supply of steel [illegible] for the electricity department.

[illegible].—The Guardians [illegible] accepted the tender of [illegible] Electric Lamp Co. for the supply of [illegible] lamps.

APPOINTMENTS VACANT AND FILLED.

[illegible] Board require [illegible] with experience of [illegible] and three-phase [illegible] 10s. per week), and a [illegible] attendant with experience of [illegible] generators and batteries [illegible] per week. Applications to the Engineer-in-Chief, generating station, [illegible]. *See advertisement.*

A headmaster is required for the [illegible] to act also as superintendent at the [illegible] in the same building. Commencing salary £300 per annum. Applications to the Director of Education, Sir Thomas-street, Liverpool, by Nov. 22. *See advertisement.*

An engineer is required for testing and calibrating switchboard instruments. Applications to the General Manager, L.C.C. Tramways, 62, Finsbury-pavement, London, E.C. 2. *See advertisement.*

Applications are invited for the position of Principal of the Coventry Municipal Technical School. Commencing salary £600. Particulars from the secretary (Mr. Frederick Horner), Education Department, Council House, Coventry. Applications by Dec. 1. *See advertisement.*

A teacher of engineering subjects is required for the day department of the Walthamstow Technical Institute. Salary £180, rising to £250. Applications by Nov. 20 to the Clerk to the Governors, 1, Selborne-road, Walthamstow, E. 17, from whom forms can be obtained.

An advertiser requires a draughtsman conversant with the designing of dynamos and motors, shafts, spiders and ball bearings.

Mr. W. A. Toppin, testing and commercial assistant at Greenock, has been appointed assistant electrical engineer at Chesterfield electricity works, at a commencing salary of £250.

BANKRUPTCIES AND LIQUIDATIONS.

Claims against Carbonoid (Ltd.), Eldon-buildings, Eldon-street, London, E.C., are to be sent to the liquidator, Mr. H. de V. Brougham, 33, Carey-street, London, W.C. 2, by Nov. 15.

An application for the discharge of Alfred Ernest Felgate, electrical engineer (trading with Wm. Storey as Felgate & Storey), 10, Queen Victoria-street, Reading, will be heard on Nov. 22 at the Assize Courts, Reading.

A meeting to receive an account of the winding up of the International Vanadium Co. (Ltd.) will be held at 8, Victoria-street, Liverpool, on Nov. 30.

BUSINESS ITEMS.

Mr. J. E. Dobson, late Scottish representative of [illegible] & Co., Ltd., Edinburgh, has been appointed London office manager to the Company, in place of the late Mr. R. W. Gauntlett, and has now taken up his new duties at Hastings House, Norfolk-street, Strand, W.C. We feel sure that Mr. Dobson's many friends both in Scotland and elsewhere will wish him every success in his new appointment.

Plant Wanted.—St. Annes-on-the-Sea electricity department want prices and particulars of 1,000-ampere 500-volt generator switch panel, and about 100 yds. insulated conductor [illegible]. *See advertisement.*

Scrap Metals.—Mr. A. Joseph, Earl-street, London-road, Southwark, S.E., notifies that, having undertaken on behalf of the Ministry of Munitions to purchase scrap metals which are now urgently required for the [illegible] of munitions, he has [illegible] the manufacture of solder for the present, and [illegible] his entire resources as far as possible to [illegible] scrap material for Government requirements.

"**A First Course of Electric-Light Switching and Testing.**"—[illegible] road, London, N. 7.

[illegible]

Card Calendar. [illegible]

[illegible]

Lantern Slides. [illegible] coal [illegible]

[illegible] addressed to [illegible]

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Bradford.—The accounts of the tramways department for the year ended March 31 show gross capital expenditure £1,042,927, of which £493,783 has been repaid or provided for repayment. The total amount provided out of revenue for relief of rates is £136,035.

Revenue was £356,025 (compared with £341,623 in the previous year) working expenses were £267,459 (£254,951), interest required £17,893 (£19,569), rent of leased lines £3,490 (£3,926), repayment of loans and contributions to sinking fund £26,596 (£26,657), and the net profit was £30,802 (£29,771). Total revenue per car mile was 14·037d. (13·209d.), and working expenses, including power, but excluding parcels, railless traction and Bowling Hill and motor garage departments, were 10·063d. (9·45d.). Traffic revenue on the railless system was 13·674d. (12·842d.) per car mile. Total passengers carried were 77,074,546 (74,082,612), total car miles run 6,086,770 (6,190,582), and railless car miles were 357,788 (322,390). Units used were 12,422,950 (12,435,679) = 2·04 (2·005) per car mile. Average fare charged per mile was 0·548d. (railless, 0·65d.).

The railless traffic revenue was £10,705 (£8,779), and working expenses were £11,290 (£8,375), showing a deficit of £585 (compared with a gross profit of £404).

Mr. C. J. Spencer (general manager) says in his report the amount spent on repairs to cars shows a decrease of £9,344, owing to the depletion of the engineering staff to about half normal and to the difficulty of procuring material. After the war large sums will have to be spent upon repairs to cars. Mr. Spencer advocates the building up of the reserve fund to meet the inevitable expenditure of large sums after the war to restore the undertaking to its pre-war level.

The income from parcels traffic was £11,729 (£11,272), and expenditure £12,076 (£11,006), the net result being a deficit of £347 (against a profit of £266).

To meet the deficiency in transport services and the shortage of motor spirit, one of the original railless trolly vehicle chassis was adapted to take a long, broad lorry. The vehicle is capable of running by power obtained from the tramway overhead wires, and also by energy from storage battery carried on board, when it is desirable to work the vehicle along routes where there are no tramways. The wagon is surmounted by a trolley pole to enable attachment to be made to the overhead wire, and earth attachment can be effected at will. The accumulators employed are of the Edison type (120 cells) giving a normal voltage of 150. They supply current to the ordinary 500 volt motors, the only difference being that the motor with battery supply runs correspondingly slower. When the vehicle is running on the 500 volt circuit the batteries [illegible] with the motors, thus becoming charged whilst the car is in service. The battery is capable of running the vehicle about 10 [illegible] before requiring re-charging. The change over from battery to overhead wire is merely a question of throwing over a switch, the [illegible] on the wire and the earth connector on to the steering gear and rail. The first trials of this vehicle were in the con[illegible] between the railway yard and various warehouses in [illegible] demonstrated the capacity and capability of the [illegible] the carriage of goods partly on and partly off [illegible] however, it has been engaged upon the carriage and distribution of material from the tramway stores to the [illegible] and in the conveyance of material to and from the [illegible] it has proved almost invaluable.

In [illegible] from the Ministry of Munitions and [illegible] for assistance in transporting material [illegible] to the company's works, the [illegible] to enable the work to be undertaken [illegible]

[illegible]

The 4-ton electric lorry has been in commission from the beginning of the year with very satisfactory results, and during the first six months hauled 3,110 tons of coal, which at contractors' rates would have amounted to £277. By electric haulage the wages and electricity cost £107, and taking the life of the vehicle at eight years, and setting aside £78 for depreciation and £46 for repair fund, a total cost of £231 is obtained, which shows a saving of £46 on the six months' working. The most expensive part of the lorry, the battery, is guaranteed by the makers to be in proper working condition at the end of eight years, and although £46 has been set aside for repairs, actually there was only nominal expenditure. During the last three months a bonus system has been introduced in connection with the lorry, and 2,215 tons were carted during this time, a 42·5 per cent. weekly increase. The cost by horse haulage would have amounted to £203, and by electric was £132 on the above-mentioned basis, giving a net saving of £71, or at the rate of £250 per annum. Incidentally it may be mentioned that the staff car has also given satisfactory results, and but for a weakness in the design of the chassis its maintenance would also have been exceptionally low.

The tramway accounts show gross capital expenditure £286,764, of which £126,595 has been repaid. Revenue was £91 834 and working expenses were £69,814, plus war allowances £5,824, leaving a balance of £16,296. Interest and income-tax required £10,475, and sinking fund and loan repayment £7,455, the net result being a deficit of £1,633. Revenue per car mile was 10·76d., and working expenses were 8·259d., including power. Passengers carried were 19,050,407, car miles run 2,027,135, and units used 2,441,277.

NEW COMPANIES.

McBAIN BROS. (LTD.) (148,800). Private company. Reg. Nov. 1, capital £5,000 in £1 shares, mechanical, electrical, marine, constructional, interbal comnustion and general engineers, aircraft builders, &c. Agreement with W. J. and A. McBain. First directors are W. J. McBain and A. McBain. Se retary: A. G. Greaves.

H. G. NORTON & CO. (1917) (LTD.) (148,739). Private company. Reg. Oct. 25, capital £5,000 in £1 shares motor car, cycle and electrical engineers and agents, ironmongers, motor car body builders, &c. Agreement with F. Woolnough (trading as H. G. Norton & Co.). First directors are Lieut. F. Woolnough and H. G. Norton. Reg. office: 416, High-street, Cheltenham.

PULP PRODUCTS (LTD.) (148,788). Private company. Reg. Oct. 31, capital £5,000 in £1 shares, pulp crushers, peat and box pressers, briquette makers, manufacturers of boiler and pipe coverings and fire-resisting material, makers of paper pulp, asbestos and fibrous substances, electrical and mechanical engineers, &c. Agreement with W. J. Poulter. First directors are H. M. Lewis and E. Bennett. Secretary: H. M. Lewis.

WEYBURN ENGINEERING CO. (LTD.) (148,792). Private company. Reg. Oct. 31, capital £15,000 in £1 shares, engineers, tool makers, tube makers, electrical engineers, enamellers, &c.

CITY NOTES.

BRITISH THOMSON-HOUSTON CO. (LTD.)—The Right Honourable Lord Carmichael, G.C.I.E., K.C.M.G., has accepted a seat on the Board of this company.

INDIAN ELECTRIC SUPPLY & TRACTION CO. (LTD.)—An interim dividend of 2½ per cent. (being at rate of 5 per cent. per annum) has been declared.

ISLE OF WIGHT ELECTRIC LIGHT & POWER CO. (LTD.)—In view of the reduction of profits the directors have decided to postpone payment of the half-yearly dividend on the preference shares due Nov. 1 until the accounts for the whole year are available.

MONTEVIDEO TELEPHONE CO. (LTD.)—The directors report for the year ended July 31 last states that, after providing for all charges in Montevideo and London, and making provision for income-tax and excess profits duty, the net profit amounts to £26,323 15s. 4d., against £25,985 3s. 8d. for the previous year. The interim dividends paid on May 1 last absorbed £4,342 14s., leaving £21,981 1s. 4d., to which is added £5,694 1s. 11d. brought forward, making an available balance of £27,675 3s. 3d. After applying £8,000 to depreciation of the Company's property and plant, and transferring £9,000 to reserve for renewals, the directors recommend payment of final dividends of 2½ per cent. [illegible] upon the preference shares and 3 per cent. (tax free) upon the ordinary shares, making with the interim dividends already paid 5 per cent. on the preference shares and 6 per cent. on the ordinary shares for the year, leaving [illegible]32 9s. 3d. to be carried forward. There has again been a satisfactory increase in subscribers during the year.

NORWICH ELECTRIC TRAMWAYS CO. (LTD.)—Mr. Francis Fitzgerald, who presided at the meeting last week, said that the decrease of £438 in the net profit was due to increased expenditure. After paying a dividend of 3 per cent. for five years, the directors were obliged to return to the old rate of 2 per cent., as a serious necessity had arisen of substantially adding to the reserve fund, in view of the large amount of reconstruction work that must be undertaken all over the system as soon as circumstances permitted. The demand for rails after the war was likely to exceed the sources of supply, and they must be prepared for an increase in the price of material for several years to come.

THE ROUND TABLE.

By "KVA."

EVENT OF THE WEEK.—An Osram lamp delivery van *driven by gas.*

* * * *

A recent article in "Flight" describes an "A.E.G." aeroplane used in the bombing of London and provincial industrial towns; which explains the former London office and branches in all parts of the country. Well, as I remarked on a previous occasion, Never AEGain!

* * * *

History often repeats itself; here is an illustration from a St. Helens Cable Co. tyre advertisement, published some time before the war. It was their idea in those days of "Taking cover." How different now!

* * * *

The lay press has been much concerned since the Admiralty announced that an "electrically-controlled" ship had been sunk off the Belgian coast. "W. J. G., in the "Star," however, eclipses them all by quoting (or, is it misquoting?) Tesla. It is rather long, but it's too good to miss:—

Ten years ago Tesla declared the time was not far distant when all the tremendous wastes of war would be stopped.

"The battles of the future," he said, "if there are battles, will be fought by water power and electrical waves." He severely criticised the construction of such "monstrosities" as battleships of the Dreadnought type, and outlined a method by which a whole fleet of Dreadnoughts could be destroyed by a wirelessly controlled "telautomaton," partly submerged, and guided by a wireless operator many miles away. The telautomaton, which would carry 30 or 40 tons of high explosives, could be directed towards a hostile fleet, and at the moment when the result of the explosion on the fleet would be a maximum it could be sunk [illegible] to the proper depth and [illegible].

The potential energy of this explosion, he explained, would be 66,000,000 foot tons, of which the [illegible] energy would be [illegible] per cent. [illegible],000,000 foot tons [illegible] to create a tidal wave of such magnitude that within a quarter of a minute a [illegible] 600 ft. deep would be scooped out of the water around the hostile vessels, [illegible] surrounded by [illegible] in diameter at the rate of over 200 ft. [illegible] Tesla asserted, would destroy an entire fleet of warships. A Dreadnought of 30,000 tons, [illegible] at a considerable distance from the origin of the disturbance, would experience a pressure of [illegible] tons per square foot, or eight times the force of the [illegible] all its [illegible] at once. For some [illegible] the vessel would be entirely submerged, and then dropped [illegible] the ocean [illegible] a height of 75 ft., never to rise again."

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN, November 6, 1880.]

TURKEY.—Messages in code or cypher can no longer be received for Turkey and Bulgaria.

INTERESTING TO CITY CLERKS.—It is rumoured that the counter-men at telegraph offices throughout the City are again to be displaced to make room for girls. This is great news for merchants' clerks, office boys, and gay loafers generally, but not for their masters.

BOW STREET.—The whole of the rooms of a "kiosk" which has just been opened in Bow-street are lighted by electric lamps on Messrs. Siemens' system, the engine below, in addition to assisting in the manufacture of aerated waters, driving six lights of 300 candle-power each.

CONSOLATION FOR THE GAS COMPANIES.—Messrs. Crossley Brothers have constructed no fewer than 1,250 gas engines—probably even many more, as that number is said to be actually in use in England alone. The gas companies themselves are employing them. This is the beginning of a wiser policy, it may be hoped.

MUNICIPAL FORESIGHT.—The [illegible] Corporation [illegible] the proposal to purchase the town gasworks, on the ground that there is "the probability that lighting by gas will shortly be superseded by other means of lighting." What other? As oil can hardly be meant, there is an excess of caution about this prediction reminding us of "another" place.

CHILLS.—Probably the worst blunder ever made by the telegraphists was one that occurred in the case of a St. Louis merchant, who, while in New York, received a telegram informing him that his wife was ill. He sent a message to his family doctor, asking the nature of the sickness, and if there was any danger, and received promptly the answer, "No danger. Your wife has [illegible]. If we can keep her from having another to-night, she will do well." The mystification of the [illegible] husband was not removed until a second inquiry revealed the fact that his wife [illegible] had had a "chill."

Water Power Utilisation in Scotland.—A special meeting of the Fort William Town Council was held last week in order to consider the steps to be taken in regard to the projected scheme for using the waters of Lochs Laggan and Treig.

The clerk explained that [illegible] proposal was to divert the water of Loch Laggan into Loch Treig, raising the level of the latter loch by about 40 ft., and the accumulated waters were thereafter to be conveyed by means of a tunnel to [illegible].

Councillor MALCOLM said that the whole of the [illegible] would be within the county of Inverness, and that there was no thought of taking the water or the power out of [illegible]. A provisional order was to be promoted shortly, and any parties who wished to object would have an opportunity of doing so.

Councillor MALCOLM said he believed the intention was [illegible] the works at Kinlochleven.

Bailie CAMERON thought it would be a good [illegible] water be taken from [illegible].

It was arranged to [illegible] landed proprietors [illegible].

Ludlum Electric Furnace.—[illegible] tilting furnace [illegible] the [illegible]

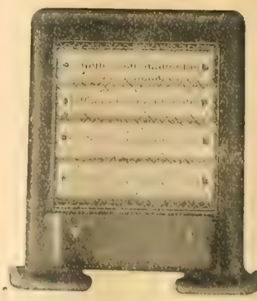
[illegible]

Electric Traction in [illegible].—[illegible]

THE PLEXSIM HOT-BAR FIRE.

The Simplex Conduits, Ltd., Garrison-lane, Birmingham, has sent a copy of their latest fire leaflet, which contains particulars of their Plexsim hot-bar fire. The firm make rather special claims on behalf of this fire. The bars are suspended on sensitive springs which absorb shock and allow for expansion. As a consequence

the fires, notwithstanding the roughest treatment in transit, arrive and remain intact. This is a great improvement upon previous designs. The electrical connections are all of the heavy, bus-bar order, robust and generous and are a vast improvement on the loose wire and beads which many makers still think good enough for electric heaters. The bars are easily removed and replaced by the mere



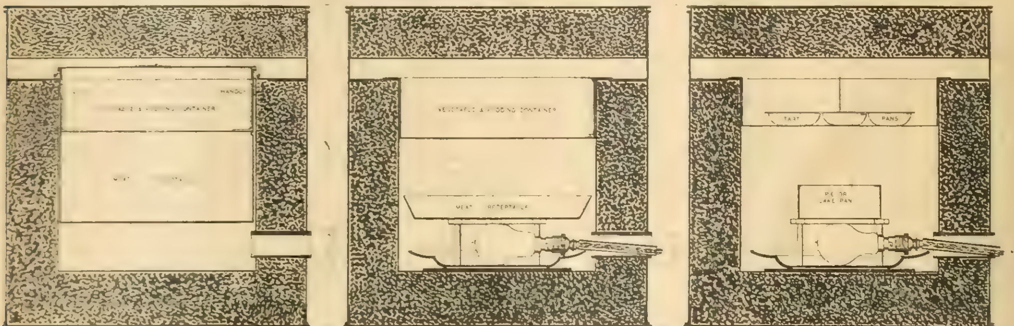
PLEXSIM FIRE IN HEAVY CAST IRON.

loosening of two screws. Any quite unskilled person can effect the renewal of a bar in one minute. As the everlasting fire is like human perfection, still in the seeking, this is a somewhat important matter. The designs of the fires are dignified and pleasing, their simplicity being somewhat of a change from the meretricious ornament which disfigures many of the cast iron fires with which one is familiar.

Telephony in Argentina. The Argentine National Government has authorised [illegible] Domingo Caddiu (junior) to establish and [illegible] a public urban and inter-urban telephone service in the districts of Esteban Echeverria, Cañuelas, San Vicente and Matanza (Province of Buenos Ayres). The service is to be connected with the [illegible] of the Sociedad Co-operativa Telefónica.

A PORTABLE ELECTRIC LAMP COOKING BOX.

In these days, when economy in the consumption of food and in methods of cooking are so important, any device for reducing the cost of cooking deserves serious consideration. In this connection it is interesting to note that Mr. Leoline Edwards, 81, St. Margaret's-road, Twickenham, London, S.W., has recently designed a portable electric lamp cooking box, which he claims to be very economical for the purpose of cooking small quantities of food. The box, which has been provisionally protected, is 18 in. in diameter and 30 in. high and weighs only 30 lb., and therefore can be easily transported. It can be carried anywhere, and the cooking can be done in the drawing room or in a bedroom without causing dust or refuse of any kind. The sole heat is derived from one 32 c.p. carbon filament lamp. The box can be left unattended, and it can be left working whilst shopping or other work is being done. The power consumed is about 120 watts. The mode of construction is as follows: There are two cases of iron, an inner and an outer one, insulated with "Quidos" expanded cork. The electrical connections of the cooking box are quite simple, and they can be attached or detached by any one at will. A socket of flex is passed through a hole left for same in the box. The lamp is fixed from inside, and connected to any fitting. The lamps are, of course, readily obtainable of any voltage. Through an aperture in the box a faint beam of light escapes, and indicates that the lamp is at work. Mr. Edwards states that practical and successful tests have been made of steaming and stewing foods, of roasting and stewing by same operation, and of baking pies, cakes and pastries.



Although not put forward as a water heater, it may at times be convenient for this purpose in summer, or in case of illness as a stand-by. If water is put in hot, it can be kept hot ready for use any time of the night or early morning; if put in cold (50°F.), the lamp will heat $1\frac{1}{2}$ gallons (12 pints) to 200°F. in seven hours, at a cost of 1d. The box, which has been designed for the purpose of dealing with small quantities of food, and does not compete with the larger operations in cooking, will, we are informed, be put on the market

shortly. Cooking a dinner for three persons (from actual practice), consisting of 3 lb. of beef (roasted), with potatoes, steamed turnips, beans, rice and prunes, was done in 3½ hours. The cost, including electric current for lamp, renewal of same, gas for previously bringing to the boil four saucepans containing vegetables, rice and prunes before putting into the box, was ¼d. Views of the apparatus which can be seen and tested any time by appointment, are given in the illustration.

ELECTRICALLY-DRIVEN STONE-CRUSHING PLANT.

In a recent issue of the "Electrical Review" of Chicago, particulars are given of the rock crushing and screening plant of the Brownell Improvement Co. at Thornton, Ill. The plant, which has a capacity of 8,000 cubic yds. a day, is said to be the largest of its kind.

The material consists of a hard, fine-textured limestone, having no overburden, and which is quarried to a depth of about 40 ft., from a pit about 2,500 ft. sq. Close to the eastern border of the pit is a basin about 125 by 150 ft. which was excavated some years ago to a depth of 40 ft. below what is now the main pit level. This basin is kept nearly filled with water, the sources of which are springs in the vicinity. Two centrifugal pumps, of 2,400 gallons and 2,300 gallons capacity, respectively, each driven by a 75 H.P. motor, are stationed at the brink of the basin to pump water to the condenser in the power station, to the boiler room, and for general purposes. The rock is broken in the pit by blasting with dynamite. Six inch holes are driven vertically to a depth of 45 to 50 ft., by Loomis motor driven drills. There are 11 drills in use and each drill is operated by an 11 H.P. motor. About 100 such holes are driven, 18 to 20 ft. apart. A charge of dynamite is placed in the bottom of each hole, with cap adjusted and connection made to an electric wire; the hole is filled half way, and another dynamite charge is similarly placed about midway between the bottom and the surface. When all is in readiness, 100 holes are simultaneously shot off by electricity from an a.c. circuit. The rock thus broken is loaded into Griffin Wheel Co. 8 yard cars by Bucyrus 3½ yard steam shovels of which there are seven in the pit; the loaded cars are hauled by American Locomotive Works 30 ton steam locomotives to the east side of the pit, where inclined tracks run about 100 ft., at a 40 degree angle, to the initial bins and crusher outside the pit. All operations are by means of electric power.

At the power station there are three 500 H.P., coal-fired, Milne boilers, an Allis-Chalmers steam turbine (rated at 1,500 H.P., speed of 3,600 r.p.m.) direct-connected to a 1,000 kw., a.c. generator, rated at 480 volts, three-phase, 60-cycle, 3,600 r.p.m. There is a direct-connected exciter for starting. In addition there is a small sub-station plant, adjoining the boiler house, where an Ideal compound, tandem engine drives a 375 kilovoltampere, three-phase, 60-cycle, 440-volt, a.c. machine. Power from this generator is utilised as a reserve and for driving the 11 drill motors. Lighting service is supplied from a 19 kilowatt, direct current, 110 volt dynamo, driven by an a.c. motor.

The two inclined tracks, over which cars of ore are pulled out of the pit to the crushing plant, terminate in automatic dumping devices above the crusher bins. The track terminals are supported by a double tower structure, containing two winding sheaves, one for each incline. Near the base of the tower structure are two small buildings, each containing an Allis-Chalmers winding hoist, operated by gear connections to a 100 H.P. motor. A 1¼ in. steel-stranded cable, attached to the hoist runs up over the winding sheave in the tower, thence to the dump cars that operate on the incline. The hoisting operations are directed by two operators from two controlling stations in the double tower, each one by means of a Cutler-Hammer drum-type controller. With this equipment close on 1,000 cars of rock per day are pulled out of the pit and dumped into the crusher bins. These hopper shaped bins feed direct into a No. 24 Allis-Chalmers gyratory crusher, operated by a 200 H.P. motor, the power being transmitted by 12 single-rope drives. The rock, after passing the big crusher, has a maximum size of about 5 in. It is carried from the crusher pit by a pan-conveyer to the top of the main mill building, the conveyer being operated by a 200 H.P. motor. The conveyer discharges upon a large grizzly. Fines passing the grizzly drop into a bin, and are carried by belt conveyer to revolving screens; the grizzly over-size rock is recrushed by four No. 7½ Allis-Chalmers crushers.

The crushed rock from the four No. 7½ crushers is classified by two sets of revolving screens on the same floor, each set of two screens being run by a 100 H.P. motor, belt-connected. The screen fines are reclassified in other finer screens, and the oversize drops into bins and is then recrushed. Stationed upon a deck above the second floor are five 100 H.P. motor by which ten sets of rotary screens are operated through belt connections on this floor. The coarse or screen oversize from the ten screens passes by belt conveyer into bins, from which it is fed into eight Allis-Chalmers No. 4 crushers for further reduction, one 50 H.P. motor serving each two crushers in the battery. The fines or screens undersize are further classified over ten shaking screens all operated by the above-mentioned motors. The crushed rock from the No. 4 crushers is screened and classified in the same manner. The last crushing gives coarse grades from 2⅝ in. to ½ in. and fines classified as to various meshes. The finished products are finally elevated and passed through fine revolving and shaking screens, thence into the shipping bins. Current from the generator room is conducted to the four distribution panels in the mill through metal conduits. One panel serves the 100 H.P. motors and others serve motors of other rated capacities. There are 43 motor installations at the plant of a combined capacity of 2,453 H.P.

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CONTENTS.

NOTES.

The Production of High Temperatures.

LAST week the Faraday Society held a very successful and interesting discussion upon "Pyrometers and Pyrometry," during which a number of Papers were read. One of the most interesting of these was that by Dr. E. F. NORTHRUP, of the United States. Dr. NORTHRUP points out the difficulties met in attempting to obtain high temperatures. Such temperatures can, of course, be obtained by means of the electric arc, the limit being set by the vaporisation of the carbon; but the use of electrodes in this case may introduce impurities. Carbon may also be used as a resistor, thus avoiding the arc. In this case, at high temperatures the carbon proceeds to unite with other bodies, and also tends to disintegrate, so that minute particles fly about, even in a reducing atmosphere. Instead of carbon, a metal such as tungsten may be used; but in that case the metal must be protected from oxidation by means of some reducing atmosphere. Leaving these difficulties on one side, it must be remembered that as the temperature of a resistor furnace rises, the temperature difference between the resistor and the [illegible] becomes less and less, whereas the temperature difference between the resistor and the outside atmosphere [illegible]. Consequently, as the heating proceeds, the temperature gradient becomes less and less from the resistor inwards and remains [illegible] from the resistor outwards, so that the bulk of the energy is dissipated [illegible] instead of [illegible] to the [illegible].

More Efficient Methods.

THE only efficient method of heating is, therefore, one in which the heat is generated [illegible]. This is effected in the ordinary induction furnace. Unfortunately, this furnace suffers from the difficulty of two interlinked magnetic circuits, which introduce considerable complication in construction and a low power factor. Dr. NORTHRUP has overcome this difficulty by the use of high-frequency currents. By using such currents magnetic material is avoided. The furnace is surrounded by a coil of [illegible], and when this is traversed by a high-frequency current eddy currents are induced in the crucible and its contents [illegible], and thus heating is obtained where required with the simplest form of construction. Dr. NORTHRUP obtains his oscillatory currents by the usual means of condensers and inductances. So far, a 20 kw. furnace has been constructed. This type of furnace has the further advantage of operating at practically unity power factor. The model described by Dr. NORTHRUP is capable of melting 15 lb. of brass in 35 minutes, starting at room temperature. The pressure used at the condenser terminals is 5,400 up to 7,200 volts, and it appears that equally good results have been obtained when working with frequencies of 25,100 and 12,500 per second. It appears to us that the application of high-frequency currents in this direction is very promising, at least for furnaces of the laboratory type and vacuum furnaces, or for commercial purposes where [illegible] high temperatures are required.

Engineering Etiquette.

WE have dealt at some length with Mr. C. H. WORDINGHAM'S Presidential Address to the Institution of Electrical Engineers on another page, but the address touched upon so many points that we may be permitted to refer to another topic in these notes. We hope that engineers will take to heart the view expressed by Mr. WORDINGHAM that there should in future be a greater observance of etiquette between engineers in their respective spheres of work. He referred particularly to consultants and manufacturers. [illegible] the consulting engineer in electrical engineering [illegible] firmly established [illegible] of the industry as consulting engineers in what [illegible] termed civil engineering. We suppose that [illegible] the contracting, as distinct from the manufacturing [illegible] position in the latter. Be that as it may, it is true as Mr. WORDINGHAM [illegible] that there is a tendency [illegible] with electrical engineering, and [illegible] especially to [illegible] the consulting engineer. We agree with Mr. WORDINGHAM [illegible] [illegible]. We have [illegible] of high standing [illegible] the requirements of the [illegible] [illegible] [illegible]. On the other hand, we [illegible] need to [illegible] from [illegible]. We think it must be said that [illegible] the part of [illegible].

Tramway Maintenance.

We are glad to note that a Committee has been appointed by the Board of Trade to exercise control of material and labour for the maintenance of tramways. During the past year the position of tramways has become serious. In industrial towns the trams have been required to a greater extent than in peace time. The wear and tear has, therefore, been heavier. On the other hand, there has been increasing difficulty in obtaining both materials and labour. In many cases the track has become seriously worn, and, as is well known, a worn track on curves and at points where there are gradients is liable to cause accidents. As regards labour, this difficulty will no doubt be emphasised still further now that the leaving certificate has been abolished. It is highly desirable, therefore, that steps should be taken to deal with the situation comprehensively, and to allocate both material and labour where it is most required. It is to be hoped that the new controlling Committee will effect this desirable object

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Institution of Civil Engineers.—The Council of the Institution of Civil Engineers have made the following awards for Papers published in the "Proceedings" without discussion during the session 1916-1917 :—

A Watt Gold Medal to Major H. S. B. Whitley, R.E. (Neath); Telford Premiums to W. C. Popplewell (Manchester), Herbert Carrington (Woodley, Stockport), Dr. A. A. Stoddard (Bournemouth), A. E. L. Chorlton, C.B.E. (Lincoln), and B. M. Samuelson (Rangoon). The Manby Premium to R. Bleazby (Perth, W.A.); the Webb Prize to J. B. Ball (London). The Howard Quinquennial Prize has been awarded to Dr. W. C. Unwin, F.R.S.

"The Ohm."—We have received a copy of the October issue of the "Ohm," a Japanese journal devoted to electrical interests.

We learn from our interesting contemporary that there are a dozen electrical periodicals in Japan, but as they are all written in Japanese it is thought that English and American electrical engineers may not be able to keep in touch with the latest developments of the industry in the Island Empire of the East. Consequently, the ".Ohm" will in future contain a column of electrical news in English. This is an interesting departure and is indicative of the spirit of enterprise and progress which animates our Ally.

Decimal Coinage.—At a recent joint meeting of the Institute of Bankers, the Association of Chambers of Commerce and the Decimal Association unanimous agreement was secured as to the retention of the £ sterling as the monetary unit and its division into 1,000 parts or mils. This enables all the existing gold and silver coins down to and including the 6d. piece to be retained without any alteration in their respective values. In regard to the coins of lower denomination it was unanimously agreed that they shall consist of 1, 2, 3, 4, 5 and 10 mil pieces, of which the two lower would be of nickel.

Institution of Electrical Engineers.—Before Mr. Wordingham delivered his presidential address last week, Mr. W. M. Mordey proposed a resolution of sympathy with Mr. Duddell's relatives and of appreciation of Mr. Duddell's work, and displayed the insignia of the Order of the British Empire which had only come to hand two days before. Mr. Mordey remarked that it might be truly said that Mr. Duddell had [illegible] beyond his strength on various problems connected with the war, and that he had died in the service of his country. [illegible] the new president, Mr. Sparks (the retiring president) referred to the career of Mr. Wordingham in the [illegible], first with Mr. Ferranti at the Grosvenor [illegible] in Manchester, which had since grown to be one of the largest undertakings in the country, and now as chief electrical engineer to the Admiralty.

Tramway Maintenance.—It is officially announced that, in view of the difficulty of meeting the demands for labour, material and [illegible] for the maintenance and renewal of [illegible] of the tramways [illegible] the Board of Trade are appointing a committee [illegible] the needs of these undertakings so that the necessary steps may be taken to supply as far as possible such needs, even at some temporary sacrifice by less essential undertakings.

The Municipal Tramways Association and the Tramways and Light Railways Association are being invited to nominate members of the committee, and the Board have asked the London County Council to allow Mr. A. L. C. Fell, the manager of their tramways, to serve on it. Mr. James Devonshire has been invited to be chairman of the committee. It is not intended that the control of the tramway undertakings should be interfered with by the committee.

British Standard Specification for Charging Plug and Socket for Electric Vehicles.—The Engineering Standards Committee have now issued the above specification.

The great importance of the subject was pointed out by the Electric Vehicle Committee of the Incorporated Municipal Electrical Association. After consideration it was decided to adopt the dimensions recommended by the Electric Vehicle Association of America in order that interchangeability should be secured between plugs made in both countries, and the report was issued in December, 1915. Early in the present year the Standards Committee (Electric Vehicle Division) of the Society of Automotive Engineers of America suggested a small modification in the design of the plug which they found added considerably to the mechanical strength and did not affect the interchangeability. The proposal was supported by the Electric Vehicle Committee of the I.M.E.A., and after consideration by a sub-committee of the British Engineering Standards Committee the modification was adopted. The revised report was approved by the Main Standards Committee in July of this year and is now issued in accordance with the new policy of the Committee in octavo size, price 1s., and French, Italian and Spanish translations will be available shortly.

Electrically-Controlled Motor Boats.—On November 3rd the Admiralty announced that an attack by an electrically-controlled high-speed boat was defeated and the boat destroyed. The Admiralty now state that the electrically-controlled motor-boats used on the Belgian coast are twin petrol engined vessels partially closed in, and travel at a high speed. They carry a drum with between 30 and 50 miles of insulated single-core cable, through which the boat is controlled electrically. The forepart carries a considerable charge of high explosive, probably from 300 lb. to 500 lb. in weight. The method of operating is to start the engine, after which the crew leave the boat. A seaplane, protected by a strong fighting patrol, then accompanies the vessel at a distance of three to five miles, and signals to the shore operator the helm to give the vessel. On being steered into a ship the charge is exploded automatically. The device is a very old one. A boat similarly controlled was used in H.M.S. "Vernon" (the torpedo experimental ship) as far back as 1885. The only new features in the German boats are petrol engines and W.T. signals.

The Use of Microphones for Detecting Submarines.—Water is a most excellent conductor of sound, and lends itself nicely to sound detecting systems. The fact that there are no so-called zones of silence in the water, and that it is a homogeneous medium, permits of the use of sound-detecting systems with every advantage at the outset. According to the "Telephone Engineer" (U.S.A.), much is being done in the way of employing megaphones for the detection of submarines, and some of these systems have already reached a remarkable state of development, permitting not only the presence of a U-boat to be detected, but also its exact position, so that the range can be given to a gun crew. The original microphone system employed by the Entente Powers some time ago operated quite satisfactorily, according to reports, until the Germans saw fit to mount their motors on sound-absorbing bases, thus making their submarines practically silent. However, the latest systems of microphonic detection do not rely upon the submarine's hum; hence it is of no consequence whether the German craft are noiseless or noisy, running at top speed or resting on the bottom.

Royal Society of Arts.—The programme of the Royal Society of Arts for the forthcoming session contains a series of interesting items. On November 28th Mr. G. Holt Thomas will read a Paper on "Aerial Transport after the War." In December the memorial "Trueman Wood" lecture will be delivered by Sir Dugald Clerk (December 5th). Lord Charnwood will deal with "Technical Training for Disabled Soldiers and Sailors" (December 12th), and Prof. J. Wemyss Anderson will lecture on "The Cold Storage Industry" (December 19th). In the Colonial Section, Lieut.-Col. the Hon. Sir John

McCall will deal with "Land Settlement within the Empire," on November 26th; and Mr. D. T. Chadwick with "The Trade of India with Russia, France and Italy," on December 13th. The Papers to be read after Christmas also deal with a variety of topical subjects, and include a special series of Papers devoted to the application of scientific research to the development of particular British industries. Cantour Lectures are to be delivered by Dr. H. C. H. Carpenter on "Progress in the Metallurgy of Copper" (December 3rd, 10th and 17th); Mr. C. R. Darling on "High Temperature Processes and Products" (January 21st, 28th and February 4th); and Mr. Edgar Crammond on "The Economic Condition of the United Kingdom after the War" (February 18th, 25th and March 4th). Unless otherwise announced meetings will take place at 4.30 p.m.

Iron Wire Transmission Lines.—A recent issue of the "Electrical World" gives an account of some experiences with iron transmission lines. Generally speaking such lines answer well. The mimimum cost of construction is stated to be reached with 35 ft. poles at intervals of 250 ft. to 300 ft., using No. 4 iron wire. With wires of this size no trouble from rusting within a reasonable time is anticipated. A difficulty that has been experienced in some cases is the high charging current, values as much as three times the full load current being encountered, together with a power factor of only 13 per cent. It appears that this trouble is partly associated with the use of iron poles, and there seems reason to expect better results in this respect when the supports are of wood. The essential point is that such lines appear to be fully justified from the economical standpoint; in fact, it is stated that in some cases lines would not have been run at all had it been necessary to use copper.

Warwickshire Volunteer Engineers.—Our readers in the Midlands will be interested to hear that valuable service is being rendered by the Warwickshire Volunteer Engineers (late Birmingham Electrical Engineers Volunteers) in the training of youths for the technical units of both the Army and the Navy. The Commanding Officer of the Corps is Major D. Shanks, J.P., who recently showed us over the Thorpe-street Drill Hall, Birmingham, and explained the work which is being done [illegible]

Intelligent youths of 17 years of [illegible] encouraged to join the unit and thereby be made eligible for the [illegible] services with better pay and prospect of rapid promotion [illegible] if they joined an ordinary unit. Lectures are given by [illegible] on telegraphy and signalling, the maintenance of [illegible], the construction of telegraph and telephone lines and [illegible] drill. [illegible] and equipment are provided, and the [illegible] is required to put in 14 drills of 1 hour each per month, when he [illegible] 10 drills only per month [illegible]. The equipment of the Thorpe-street Drill Hall [illegible] complete, and there is a [illegible]. The Corps has also sent a number of men to Portsmouth for service on H.M.S. Vernon, and in order to provide [illegible] for the increasing number [illegible] the Admiralty [illegible] two [illegible] the [illegible] Birmingham Volunteer Engineers [illegible] serving on these ships, and a total [illegible] on board since January 1916. In connection [illegible] men over or under military age [illegible] soldiers and men holding protection [illegible] by the Ministry of Munitions are invited to join the Corps. [illegible] urgently required, and those [illegible] interested should apply to Capt. S. F. Pendleton, the [illegible], at the above mentioned Drill Hall on Friday evenings between 6.30 and 8.30. Birmingham employers will also [illegible] in the matter of persuading those of their youths who will be [illegible] up to take advantage of the training facilities of the enterprise. [illegible]

OBITUARY.

Dr. [illegible] —The death [illegible] of Dr. [illegible] who was for some years [illegible] with Mr. Carl Hering in Philadelphia on electrical engineering [illegible] he became editor of the [illegible] Industry [illegible] and Chemical Engineer [illegible] for the past [illegible] years [illegible] of current electrical literature which has appeared in the "Electrical World." He was a founder of the American Electrochemical Society, of which he was President in 1913-14. He was also a member of the American Institute of Mining Engineers, the American Institute of Electrical Engineers and the American [illegible] Society. He was born in Germany in 1867 and emigrated to the United States in 1894.

COMMANDER C. TISSOT.—We regret to record the death of Commander Tissot, well known [illegible] wireless telegraphy. Tissot was born in [illegible]. After entering the French Navy, he showed a strong [illegible], and joined the staff of the Naval School. [illegible] he was responsible for the [illegible] on wireless [illegible] at the [illegible] of Electricity [illegible] on the theoretical side. He was also keenly interested in [illegible] in [illegible]. His [illegible] to exposure which his constitution was unable to withstand, resulting in his death on Oct. [illegible]. His published works [illegible] "Resonance in Systems of Antennae," [illegible] "Manual of Wireless Telegraphy," and numerous articles.

WILLIAM P. HANCOCK.—We regret to record the death of Mr. William P. Hancock, superintendent of the generating department of the Edison Electric Illuminating Co. of Boston, which took place on Sept. 19 at his home in Alston after a comparatively brief illness. Mr. Hancock, who [illegible] had completed 25 years' service with the Boston company. He was well known to station engineers in England, [illegible] made a regular annual trip to this country and Europe [illegible] exchange ideas and to keep in touch with the latest developments in the electrical supply industry.

PERSONAL.

One of the members of the American Mission to the Inter-Allied Conference in Paris is Mr. Oscar T. Crosby, Assistant Secretary to the Treasury. Mr. Crosby is an electrical engineer and well-known to many of our readers.

WAR HONOURS.—The following honours have been conferred:—

Sgt. J. J. Clear (attached R.E.) [illegible], formerly employed in the Liverpool tramways department, has been awarded the Military Medal for bravery in the field.

Sgt. A. J. Knight [illegible] formerly employed [illegible] staff of the Post Office Engineering Department at [illegible], has been awarded the Victoria Cross for repeated acts of gallantry under heavy machine-gun and rifle fire.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, Nov. 16th (to-day)

[illegible]

[illegible] Westminster, [illegible] S.W. [illegible] Lift Pumping," by Mr. A. W. Purchas.

[illegible]

SATURDAY, Nov. 17th

[illegible]

MONDAY, Nov. 19th.

[illegible]

WEDNESDAY, Nov. 21st

[illegible]

THURSDAY, Nov. 22nd

[illegible]

FRIDAY, Nov. 23rd

[illegible]

THE ASSOCIATION OF MUNICIPAL ELECTRICAL ENGINEERS (UNION OF SOUTH AFRICA).*

PRESIDENTIAL ADDRESS BY MR. JOHN ROBERTS.

It is now over a year-and-a-half ago since this Association in Johannesburg was inaugurated, and it is with regret we must all feel that the great event which overshadows all our lives is still continuing, though most of us believed at that time that it would have been brought to a successful conclusion ere this. In this connection we must place on record the satisfaction we must all feel at the very worthy part played in the sphere of military affairs by our past-president, Lieut.-Col. Dobson, who 15 months ago left for German East in charge of a regiment of pioneers of his own raising, and who after about six months' service in the field returned crowned with honours and with his present high rank.

It is satisfaction to us to know that the electrical engineer is playing such a leading part in this war. We must all feel that a more worthy part to play in the world's affairs is to promote comfort and civilisation rather than to engage in destruction.

Though electricity is for the present the handmaid of Mars, we feel confident that when his sword is sheathed electricity will go a long way during the long spell of peace which we hope lies before humanity to promote bonds of friendliness between the nations by spreading knowledge, improving transport and communication, and that war will one day cease on the earth.

When the war is over the engineer, and particularly the electrical engineer, will be looked to to perform the many and much-needed tasks of reconstruction to make good the fearful devastation which the war has brought about. All the overrun territories will require new railways, numberless bridges—even towns which have, in some cases, been wiped out of existence, must be rebuilt. The ship-building industry will for years be kept busy replacing the thousands of vessels now lying at the bottom of the sea. And it is not only the direct damage caused by hostilities which must be put right. The usual work of the world has been largely suspended. Thousands of miles of railways have been gradually getting into worse condition owing to the impossibility of making proper repairs; tramways have had branch lines taken up to replace worn-out rails on main tracks. House property has gone into bad repair for want of men to paint and mend. Many new schemes of development, particularly in the Colonies, are completely arrested until the war is over. In our own country the Rand Water Board has postponed a gigantic scheme to carry water from the Vaal to the Rand. The Johannesburg Municipal Electrical Scheme has two large turbines to install which cannot be delivered. The Capetown Municipality has a large water as well as sewerage scheme in abeyance. Pietermaritzburg has [illegible] extensions to its electric undertaking. In Durban large projects for establishment of industries, such as cement and [illegible] were postponed when war broke out.

And this brings me to the point of development of the local resources of the country, to which attention is already being largely directed. A committee of technical experts has been appointed to study the possibilities of [illegible] in South Africa, and it must be a matter of satisfaction to us to know that one of our own profession, Mr. Bernard Price, the chief engineer of the Victoria Falls Power Co., is the chairman of that committee.

The day is not far distant in England when the generation of power will be done in great mammoth stations and the small town will give up their small inefficient stations. But in South Africa it will be many years before the towns will be linked together into one common network, though it is bound to come one day, and the consequence is that for some time yet every town must be responsible for the supply of current within and around its borders till the [illegible] sufficiently far to meet.

Knowing as we all do the stimulation to industry which a good local supply of electricity brings about, one or two things follow:—

1. That municipal electrical engineers must wake up to their responsibilities to local industries.

2. To so design new schemes, and, if necessary, modify old ones, that they place themselves in a position to meet any reasonable demand for power that may be suggested in their territory.

3. By such a policy they may be able to promote local industries which otherwise may be driven to larger centres of population where supply of current can be secured.

Many illustrations of the third point in the above may be quoted. [illegible] bark, which up to the breaking out of war was exported [illegible] shipped from the [illegible]. It would seem to be much more [illegible] to export the extract instead of the bark, [illegible] and [illegible] the tanning product [illegible] to the [illegible] establishment of an industry to turn our own hides into leather. Such an extraction plant will soon be in operation near Durban. But why not up-country where the bark is grown? It will rest greatly with municipal electrical engineers to induce manufacturers to manufacture as near the seat of agriculture as possible instead of railing the raw material to the large towns to be manufactured there. Other cases could be quoted. The making of cheese, the freezing of beef, should all be done as near as possible to where the cattle are reared.

It would therefore be well to undertake a careful study of the possibilities of the establishment of local industries in your respective territories. The manufacturing conditions must be closely studied. Usually the owner is not acquainted with the electric drive; one has to know sufficient of his work to demonstrate not only how to solve the power problem, but to show in what way electricity will be superior to steam. In Durban we had to learn the peculiar conditions of such diverse businesses as wool-pressing, bark disintegrating, sugar refining, brick-making and cold storage, and we can now not only give advice on the electric side of the proposition, but advise on many of the technical points in regard to some of these concerns if it is asked for.

This brings me, therefore, to some mention of the South African industries which may be developed and established as a result of the committee with Mr. Bernard Price at its head. As we municipal electrical engineers stand as the exponents of electrical enterprise, we must keep before the farmer the advantages of electricity, especially in irrigation work, and should make ourselves acquainted with the immense work done in this direction in the arid parts of the Western United States.

There can be no doubt that our limitless veldt will ultimately produce meat in quantities comparable with what the Argentine is doing, and the higher standard of living in European countries will call for increasing quantities of meat for food. A large export of meat will bring with it the possibilities of many new industries, such as tanning, manure-making, cold storage plants, and every electrical engineer must be able to cater for demands for power which may arise in connection therewith.

There is not much hope, except in the case of the largest plants, to sell current for electrolytic or electro-chemical processes, or for electric furnaces. But it is stated that an electric steel furnace is already at work on the Rand, as well as a plant for making calcium carbide in an electric furnace. The cost of power in small plants is usually much too high to attract such industries as these, and the engineer of the small station has a difficult problem in bringing down his cost to a figure comparable with what can be obtained in the large undertakings. His difficulty is the small output, the cost of attendance and capital charges, the standing charges in fact amounting to a large figure per unit owing to the small output. And this brings me to the next subject on which I shall touch in this brief address.

It is the importance to the small station of so designing the plant as to be able to deal with demands for power at moderate charges. The total cost in the small undertaking is, as I have said, high in most cases because the standing charges are excessive, due to the small production, but this cost would automatically fall if the output could be brought up, such as, for instance, by the addition of a good power load, so that need not be a cause for concern. In some cases the variable costs, principally fuel, are also high, and this high figure per unit will not go down much with addition of load, and in such a case as this, then it is hopeless to try and cultivate a large output profitably. The aim must be to lower fuel and repairs cost to the minimum, so that by increasing the output the total cost will not decrease much, due, of course, to the standing charges remaining fixed. To secure such a state of things it is useless, for instance, to run a plant with non-condensing steam engines even where coal is cheap. Many engineers forget that by installing condensers you increase the capacity of your plant by at least 20 per cent. (the boilers and engines, at any rate, if not the generators) at a moderate cost, and on equal loads in addition to saving cost of fuel you save handling of coal and ashes, besides maintenance of boilers by the lower evaporation required. But even with condensing steam engines operating costs in a small plant are heavy, and something better than this must be aimed at. I do not think that the Diesel engine is the right solution. The fact that one has to depend on fuel from overseas is, I think, sufficient to condemn it. I must confess I am surprised that the gas engine has received such comparatively small support from the municipal electrical engineer of the small

* Presidential address [illegible] convention, held August 1917. Abridged.

town, though in private enterprise their success has been well demonstrated.

Another point on which I will only briefly touch is that of standardisation of systems and supplies. The need of more uniformity in all branches of engineering than now exists is really very pressing. We all know the handicaps under which we suffer now through the want of understanding between us as to such matters as the best pressures and periodicities to employ, and the complete lack of co-ordination in the plant we buy. We shall place the electrical industry under a debt of gratitude to us if we can do something to reduce the great and unnecessary variety of plant and apparatus which now has to be stocked, a condition which is bound to result in much higher prices and greater difficulties in procuring our requirements than need be the case.

We now happen to have a great opportunity before us. A few months ago the Natal Engineering Society made certain representations to the South African Institute of Electrical Engineers in regard to general engineering standardisation. It then appeared that a Standardisation Committee had been in existence in Johannesburg for many years past, but for some time its activities had been suspended. However, the outcome was that a new committee was got together embracing representatives from the following bodies:—

South African Institute of Electrical Engineers; South African Institute of Engineers; Association of Municipal Electrical Engineers (S.A.); Engineering Section Natal Society for the Advancement of Science and Art; British Electrical and Allied Manufacturers' Association; Institute of Electrical Engineers, England; Government Departments, Union of South Africa.

I had the honour of attending the first meeting held in Johannesburg in May last, and stated that our Association would probably be discussing the matter of standardisation. I was therefore asked to request the Association to kindly send any representations it cared to make for consideration of the Standards Committee. I trust that at our Convention this year we shall have time to give the matter of standardisation, both of systems and supplies, considerable attention, and go some way to put an end to the present chaotic state of affairs electrical in this country.

This important question is brought somewhat into prominence at the present time owing to a most interesting development in the railway policy of South Africa which is foreshadowed by the general manager, Sir Wm. Hoy, in his last annual report. I am convinced that on many of the sections of the railways on which traffic is now dense, where, in fact, the lines are carrying up to their ultimate capacity, notably on the Natal main line, a substantial improvement in both carrying capacity and reduction in working expenses would be achieved by the electric locomotive. The heaviest train now hauled behind an engine on the Natal gradients is 650 tons. On the Chicago St. Louis and St. Paul Railway in the United States of America, there are now 400 miles of line in regular daily operation by electricity over more difficult country than we have to contend with, and the electric locomotives on the line actually haul a gross load behind them of 3,000 tons, the grades being as high as one in fifty (2 per cent.).

Railway electrification is a matter which closely affects us in our position as almost the sole suppliers of current throughout the Union, leaving out, of course, the Rand Mines and the Victoria Falls Power Co. We are closely interested in the subject because the South African Railways have given up generating current for themselves, and now in all the principal towns of the country take their supplies of electricity from the local municipal plants. Within the next few years some understanding between the municipalities should be come to as to the terms which should be offered, class of current supplied, &c.

[illegible]

concrete poles in place of steel or cast iron poles we used to employ. These, we find, have advantages as regards durability. Steel poles being practically unprocurable, we have also adopted wooden poles (Jarrah), but the price of these is also advancing at a very formidable rate. I give below some figures which will be of interest of poles 30 ft. long:—

[illegible]	Pre-war Price.	Present Price.
Siemens type pole, weight 500 lb.	£4 4 0	Unprocurable.
Wood pole 6 in. - 4 in., [illegible] long	1 14 0	£3 7 [illegible]
Concrete pole	5 0 0	

The wood pole has a special protecting case portion to prevent destruction by white ants.

Distribution Lines and Cables.—This has been [illegible] the most difficult class of supplies. Even if procurable, the cost is almost prohibitive except in the case of small sizes of wires. We have consequently gone over our distribution plans very carefully to discover where copper is in excess, and have taken down one long overhead high tension line and made up from it three shorter lines to feed the central district, and are recovering a good deal of underground cable, which will come in for low tension distribution. We are also taking down ground wires which we regularly employed above all high and low tension overhead conductors, as we are doubtful if these are of the value we used to think they were. This will yield us considerable quantities of bare copper wire for small extensions of our lines. Fortunately the new demands from large consumers of power are not coming in fast, as such consumers cannot obtain machinery for new enterprises.

Meters.—These at the present time are very difficult to obtain, and we are putting back into service a number of old types of meters we took down as being obsolete, but which we kept in reserve for unforeseen emergencies, and they are coming in very useful now. We are considering recommending a minimum charge to private consumers so that we can recover instruments from properties where the consumption is very low, say under six units a month.

Constructional Materials.—We have had to do quite a lot of constructional work both in the power station and outside, and owing to the high price of steel sections of all kinds we have very largely used old steel tram rails for all kinds of work—generally in combination with concrete. We have built up switchboards with these rails as a framework, using asbestos "Eternit" or similar sheeting as coverings and as partitions. Latterly we have been bringing in old boiler tubes as uprights for switchboard panels. Though the general appearance is not so good, it must not be thought that the results so far as reliability goes are any worse; in fact, we have aimed at doing better work than usual now, as it is important to reduce maintenance costs on account of the shortage of skilled attendance.

Reinforced Concrete.—We have been [illegible] the possibilities of the substitution of this material for steel and iron [illegible]

[illegible]

BOOKS RECEIVED.

[illegible]

PYROMETERS AND PYROMETRY.

A general discussion on pyrometers and pyrometry took place at a meeting of the Faraday Society on Wednesday, November 7th. The chair was taken by Sir Richard Glazebrook, C.B., F.R.S.

In opening the discussion, the chairman, after expressing regret at the absence of the president, Sir Robert Hadfield, said his own personal interest in the subject was chiefly scientific. It was not until 1913 that the question of standardisation of high temperatures was taken in hand. It was at the fifth conference on weights and measures, held in Paris in October of that year, that a number of resolutions were passed which laid it down that during the next few years it was to be the work of the national laboratories represented to devise practical methods of measurement. A considerable amount of preliminary work was done with the object of introducing an international scale of high temperature, at any rate up to 1,200°C. or 1,300°C., and it was hoped to go even higher. Representatives of the Reichsanstalt visited the National Physical Laboratory, and as the result of discussing various proposals it was arranged to hold an international conference to settle the whole matter on September 25, 1914, but events proved otherwise, and that conference did not take place. Correspondence, however, went on between the National Physical Laboratory and the Bureau of Standards, Washington, and the resolutions were accepted which were referred to in Mr. Griffiths' Paper. One of the outcomes had been to establish a certain fixed point scale giving a fixed point of temperature up to 1,083°C. for melting copper in a reducing atmosphere, and that had been adopted in America and England. It was clear, however, that the scale was insufficient, and that much higher temperatures would have to be considered, and the importance of that was obvious. Cases were frequently coming under his notice at the N.P.L. in which difficulties of a metallurgical character were obviously due to uncertainty in the measurement of high temperatures, it being difficult to repeat in practical working the conditions obtained in the laboratory. The time had gone by, too, when it could be regarded as sufficient to trust to the eye and experience of any skilled workman for work requiring the accuracy needed in dealing with metallurgical problems which now had to be solved. If we were to return to our place as a nation and to advance our position we must apply the very highest and most carefully thought out results of scientific inquiry to these complicated problems.

The following four Papers were then read:—

PRODUCTION OF HIGH TEMPERATURE AND ITS MEASUREMENT.

BY E. F. NORTHRUP.

If the highly refractory properties of carbon are utilised, the attainment of high temperatures by electrical means, as in a Moissan furnace, is not difficult. The upper limit attainable is then determined by the vaporisation temperature of carbon.

The method of obtaining high temperature with the use of carbon, however, offers only a partial solution of the important problem of the heat treatment of materials at high temperatures, because in such circumstances carbon enters into chemical combination with a large number of the elements and reduces or otherwise changes many chemical compounds.

The attainment of high temperature, uniform throughout a volume, free from carbon may be obtained by using tungsten as a resistor, either in the form of a tube made to carry a heavy current, or in the form of wire or ribbon wound round a highly refractory tube. But the tungsten must be protected from oxidation by filling the furnace with some reducing atmosphere, as hydrogen. A tungsten vacuum furnace is also a possibility.

Another consideration is the inherent thermal inefficiency of every type of resistor furnace when used for producing fusion of a product which melts at a high temperature.

The above rather discouraging considerations led the writer to inquire: First, what form would an ideal furnace take, and, second, is it physically possible to reach this ideal by any application of electricity?

The ideal melting furnace is one which consists of a crucible of cylindrical form (so proportioned that the ratio of its radiating surface to its volume is a minimum) that contains the product to be melted, either electrically conducting or insulating. The product by induction alone should be capable of absorbing a large percentage of the power available, and thereby become quickly and uniformly heated until fusion with any desired superheat is obtained. The heat [illegible] in this ideal furnace should first make its appearance generally in the walls of the crucible, or, better, within the contents of the crucible. Loss of heat by outward conduction and radiation should be [illegible] possible. The final possible temperature attainable therefore should be limited only by the necessary limit set by the refractory properties of the crucible itself. A large percentage of the power supplied electrically should become directly transformed within the crucible into heat and not pass into the crucible from the outside by a process of heat-conduction.

If this ideal furnace is to be in part or wholly realised it must be by some form of induction, obtained without the use of iron, for reasons which appear below.

The customary form of construction of the induction furnace does not permit the attainment of this ideal furnace in several particulars:

1. An electric circuit and an iron magnetic circuit are always interlinked. This threading through the electric circuit of an iron magnetic circuit precludes the possibility of realising the simple crucible form of construction above described.

2. The difference between the expansion with temperature of metals and refractories makes it practically impossible, without destroying the latter, to allow the ordinary induction furnace to cool down to where its charge solidifies. Refractory linings are invariably cracked when this is done.

3. The induction furnace constitutes a step-down transformer which necessarily has large magnetic leakage. The power factor may, therefore, be very low, the supply current lagging behind its E.M.F.

4. Very high temperatures cannot be obtained in the ordinary type of induction furnace, because, if energy is supplied fast enough to replace the heat losses at high temperature, the molten material is ruptured by the mutual attraction of current elements.

5. The ordinary induction furnace does not lend itself to such form of construction that the contents may be heated in controllable atmospheres or in vacuum.

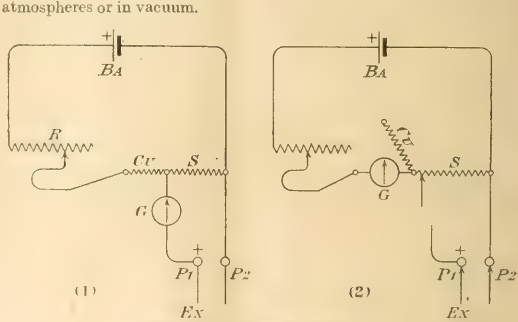


FIG. 1.—PYROMETER CIRCUITS.

With these limitations in mind, the writer sought the underlying principle which would permit the attainment by electric induction of the ideal type of simple crucible furnace. This principle has been found, and a 20 kw. furnace embodying the principle has been made.

Heating is obtained by inducing, with comparatively high-frequency currents in an inductor coil which surrounds the crucible, very large currents in the walls of the crucible or in its contents, if these are electrically conducting. The induction is obtained by electromagnetic induction without the use of any iron. The furnace differs radically from all other types of induction furnace by the entire absence of any interlinkage of a magnetic with an electric circuit. The necessary high frequency of the inducing current may be obtained from the discharge of condensers. These oscillatory currents pass through an inductor coil of about 50 turns which surrounds the crucible, and sufficiently separated from it to permit of both electrical and heat insulation. We thus have a Tesla coil arrangement in which the voltage is transformed down and the current transformed up. When a condenser of capacity C is charged to voltage V, energy is stored in the dielectric in potential form and in amount $\frac{1}{2}CV^2$. When the condenser is discharged this potential energy is released, and, becoming kinetic, may take the form of electric radiation as utilised in radio practice, or it may take the form of thermal energy or heat. Thus, it becomes purely a question of design and engineering practice so to construct apparatus and select conditions that very little energy is spent in radiation and a large percentage of energy is converted into heat within a crucible and its contents.

Apparatus consisting of adjustable reactances, high tension transformers, an entirely new type of discharge gap (which is nearly silent and operates without moving parts), two banks of condensers and a furnace inductor winding, constitutes a complete outfit for operation on a two phase 60 cycle 220 volt supply circuit.

The results so far obtained with this model furnace are as follows :—

1. It operates on a two-phase circuit, drawing an equal load from each phase.

2. It operates at full-load with unity power factor for the supply circuit or with a slightly leading current.

3. It operates at any small fraction of full-load without appreciable reduction in efficiency.

4. The metal-melting furnace will melt, starting at room temperature, about 45 lb. of brass in 35 minutes when watt-hours meters in the supply mains register a total power supplied of 18 kw.

5. The vacuum-type furnace will bring a crucible of Acheson graphite 14 cm. in diameter and 18 cm. high, filled with tin or glass, to a temperature of well over 1,600°C. in 40 to 50 minutes, and a vacuum of not less than 1 cm. of mercury can be maintained during the process.

6. Cylinders or crucibles of the above dimensions, or smaller, made of graphite can be raised to a temperature of 1,600°C. with an almost perfect uniformity in their temperature distribution. Cylinders of other materials, as of iron, nickel, or nichrome, may be raised in temperature until they start to melt.

7. The thermal efficiency defined as the ratio of heat energy developed within the crucible and its contents to kilowatt-hours supplied at switch terminals (both expressed in like units), may be made as high as 60 per cent. with the 20 kw. furnace illustrated, and it is thought that a greater thermal efficiency may be obtained in a furnace of larger power capacity.

The furnace has been operated at 5,400 and at 7,200 volts at the condenser terminals. The frequency is the natural period of the oscillatory circuit of either phase. About equally good results have been obtained when working with 25,400 cycles and with 12,500 cycles per second.

Protection from the high voltage is secured by surrounding the furnace casing with a grounded metal cage, and the crucible, in addition to being electrically insulated from the inductor coil with a cylinder of quartz glass, is likewise grounded.

The early construction of furnaces of larger kilowatt capacity is under contemplation. These furnaces should be particularly adapted to the melting of optical glass, high melting alloys, brass, gold, silver, &c.

Metal scrap, borings, turnings, &c., may be quickly raised to a melting temperature, then fused and superheated, even when contained in a refractory crucible of non-conducting material. Pure electrolytic iron, contained in a magnesia crucible, has been fused in vacuum, carbon and presumably every other source of contamination being entirely absent.

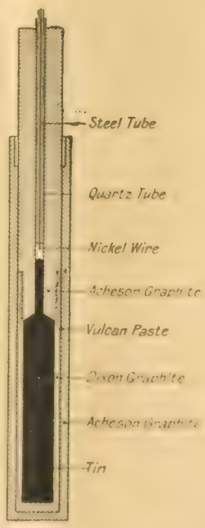


FIG. 2.—CROSS-SECTIONAL VIEW OF TIN PYROMETER.

This type of furnace cannot be destroyed by burning out, as the only parts which get at all hot are the crucible, its contents, and the immediate layers of refractory lining.

The Measurement of High Temperature.—These remarks refer to the measurement of high temperature by means of direct insertion pyrometers, radiation and optical pyrometry being excluded.

The limits to accuracy set for high temperature direct insertion pyrometers are determined chiefly by [illegible] modification of the pyrometric substance. With the best pyrometer casing tubes obtainable, at 1,300°C. gases obtain access to the thermocouple wires, and contamination is produced by the chemical activity of the hot gases.

Up to about 1,300°C. the accurate measurement of temperature in any kind of atmosphere has been satisfactorily solved by properly constructed and protected platinum-rhodium thermocouples, the E.M.F. of which is determined by a potentiometer method. The writer has devised a robust portable instrument operating on the potentiometer principle, but reading in millivolts or degrees by the deflection of a pointer.

The principle upon which the pyrovolter operates may be briefly described as follows :—

Referring to diagram 1, Fig. 1, a small dry cell *Ba*, contained in the case of the instrument, [illegible] through the rheostat *R* and the fixed resistances [illegible] due to the resistance of the copper coil of the moving element of the meter *G*), and *S*, a fixed resistance of manganin adjusted accurately with potential tap-offs. The value of the resistance included between these potential leads determines the range of the instrument. The current flowing through *S* is varied by the rheostat *R*, so that a varying E.M.F. is applied to these potential leads due to the drop of potential over the resistance *S*. The moving element is connected in series with the unknown E.M.F., Ex (through the binding posts P_1 and P_2), across this varying potential, so that the meter serves as a galvanometer to establish a balance between the unknown Ex and the drop across *S*. This adjustment is effected by turning the large black button (marked "Off") in the lower right corner of the instrument, in a clockwise direction, to increase the current flow through *S*, thus increasing the drop across *S*. When the balance has been attained, as is shown by the pointer of the instrument resting over the extreme left end of the scale (where a long, fine line is drawn to assist in setting the pointer accurately for this balance), the small button in the lower left corner of the instrument is pressed, which changes the connections to those of Diagram 2. The pressing of the button has substituted the meter *G* for the resistance *Cu*. This is permissible, since both elements are copper and hence always of the same resistance: without affecting the conditions of the circuits, a meter has been introduced which measures the current flowing through *S*, and since the drop across *S* is proportional to the current flowing through *S*, the scale of the meter is marked off to read the drop across *S*, and this drop having been just balanced against Ex, we have the instrument indicating the value of Ex.

In effect, the pyrovolter principle provides a means of operating a deflection instrument on the potentiometer principle.

Some of the advantages secured with this type of instrument are as follows: Sufficient sensibility is secured in a rugged instrument so that temperatures indicated with platinum-rhodium couples may be read with satisfactory accuracy. As the instrument operates on a potentiometer principle, the resistance of the thermocouple itself and the thermocouple leads may vary within wide limits without affecting the accuracy of the readings. The instrument is not limited to a single range, but as many as four ranges may be conveniently embodied in one instrument. The indications of the pyrovolter are theoretically and practically independent of the temperature coefficient of the instrument itself.

Though thermocouple methods of reading temperatures meet most of the requirements of laboratory and factory up to the safe working temperature limit of the platinum-rhodium couple, there are many industrial operations, carried on at higher temperatures, where a direct insertion pyrometer [illegible] very welcome.

Nature has provided us with a pyrometric substance which promises to give the result desired, namely, the metal tin which melts at 232°C., and does not [illegible] According to a determination by Greenwood* its boiling point is 2,270°C. Thus, the range of temperature [illegible] about 2,000°C., is greater than of any other known substance. [illegible] is molten. [illegible]

[illegible]

* [illegible]

THE ADVANTAGE OF BURYING THE COLD-JUNCTION OF A THERMO-COUPLE AS A MEANS OF MAINTAINING IT AT A CONSTANT TEMPERATURE.

BY ROBERT S. WHIPPLE.

In March, 1903, Prof. Anthony Zeleny, of the University of Minnesota, Minneapolis, suggested the advisability of burying the cold-junction of a thermo-couple circuit as a means of maintaining it at a constant temperature.*

Although thermo-couples have been frequently buried for the purpose of measuring earth temperatures, yet they have not, as far as I know, been buried for the purpose of maintaining the cold-junction of a thermo-electric circuit at a constant temperature. In the research laboratory, where accuracy is aimed at, it is customary to immerse the cold-junction in melting ice. As it is generally difficult to maintain an ice vessel near a furnace, this necessitates the placing of the ice vessel some distance from the source of heat. In the laboratory, where the cost of the wires for the rare-metal thermo-couples was not very serious and where the furnace employed was small, this was not a matter of great importance; but in the works, where a large number of couples are used and where long lengths of leads are required, the employment of melting ice is impossible. The difficulty has been overcome to some extent by the use of thermos-flasks. In practice the flasks are filled with oil, in which the cold-junction of the thermo-couple circuit together with a mercury thermometer, are immersed, the thermometer being a ready means of showing the temperature of the oil. In the majority of cases the daily temperature range indicated by the mercury thermometer does not exceed 2°C., although the daily temperature range of the air surrounding the flask may amount to 10°C. or 15°C.

The introduction of Peake's compensating leads † has rendered it possible to transfer the cold-junction of a platinum-platinum-rhodium or iridium couple to a considerable distance from the head of the pyrometer, so that the employment of a buried cold-junction with the rare-metal couples is rendered commercially possible.

The high price of platinum and its alloys has compelled the use of base-metal thermo-couples, and the reliability of some of the modern elements, such as the (1) nickel, nickel-chromium, (2) iron, nickel-copper, or (3) copper, nickel-copper, justifies the use of these elements to a high degree of accuracy. The materials mentioned are not expensive, and at once open up the possibility of burying as a means of maintaining the constancy of the temperature of the cold-junction.

In connection with some experimental work at the Cambridge Scientific Instrument Co., it was desired to maintain a cold junction at a constant temperature for a long period of time, and in July, 1911, one junction of a thermo-couple was buried.

For a period extending over two years—July, 1911, to July, 1913—the E.M.F. generated by the couple was measured once a week by means of a potentiometer, the other junction of the circuit being immersed in melting ice. During the period August, 1913, to June, 1914, the temperature of the couple was read at longer intervals of time, generally once a month.

The rise and fall in temperature at the autumnal and vernal equinoxes were clearly marked, even in the couple buried under the building. The times of maximum and minimum temperature agree with the Greenwich hours, but although the Greenwich thermometer is at a depth lower by 2·8 ft., yet the temperature range is approximately 3·5°C. greater than that shown by the buried junction. This is not surprising when it is considered that in the one case the ground above the thermometer is exposed to the weather, and in the other it is protected by the roof of the building.

The following are the extreme ranges of temperature (°C.) for the period under discussion:—

	Cambridge				Greenwich		
	Max.	Min.	Range.		Max.	Min.	Range.
July, 1911–June, 1912	13·80	11·89	1·91	Mean	14·61	9·11	5·50
July, 1912–June, 1913	12·95	11·46	1·49	..	13·67	8·71	4·96
July, 1913–June, 1914	13·35	11·97	1·38	..	13·50	8·77	4·73
Mean			1·59	Mean ..			5·06

In a Paper recently published by Dr. Arthur Rambaut, the Director of the Radcliffe Observatory, Oxford, he discusses the results of temperature obtained by underground thermometers at Oxford during the years 1899 to 1910, and shows that the maximum temperature range of the thermometer buried at a depth of 9 in. to 11 ft. below the surface is 6·88°C., varying from 14·42°C. in September, 1899, to 7·54°C. in March, 1909. From the mean monthly temperatures over the same period the extreme range is 5·15°C., viz., from 13·26°C. in September to 8·11°C. in March. This value is almost identical with that obtained from the Greenwich thermometer buried at 12·8 ft.

The question of uniformity of underground temperatures is also complicated by rainfall. An abnormal rainfall may raise the diffusivity of the soil, and thus cause a break in the constancy of temperature in a long series of readings. The larger the area of the floor of the building under which the buried couple is placed the less will be the likelihood of rainfall affecting the constancy of the soil temperature below it.

In conclusion, it may be stated (1) that the temperature of the cold-junction of a thermo-couple system if buried to a depth of 10 ft. beneath the floor of a fairly large building, will remain constant to within less than 2°C. throughout the year; (2) that if Peake's compensating leads are used with platinum-platinum-rhodium couples there is no practical difficulty in using the buried cold-junction in a works. If base-metal couples are used, the problem is even less complicated, as simpler means of protecting the couple can be employed, the couple generally being more robust and the accuracy required being of a slightly lower order.

* United States patent specification No. 721,770, March 3, 1903.

† See British patent specification No. [illegible] 1909, and "Methods of Measuring Temperature," by R. S. Whipple. Proc. Inst. Mech. Eng., [illegible]

THE AUTOMATIC CONTROL AND MEASUREMENT OF HIGH TEMPERATURES.

BY RICHARD P. BROWN (PHILADELPHIA).

Probably no employé has caused the average works manager to have so many sleepless nights as the furnace-man on whose shoulders rests the responsibility for the accurate heat treatment of the steel and the uniformity of the product. This applies to steel plants in the chemical industry, in the glass industry, and in the brick industry, where the kiln firing is of the utmost importance.

The old furnace-man, through years of practice, will endeavour to gauge the temperature of the furnace with his eye, but in such methods the personal element plays a conspicuous part.

This is one reason why a great amount of study has been given, not only to the perfection of pyrometers, but also to the automatic control of temperature. It has, however, been only recently that real results have been accomplished in automatic temperature control.

My experience in the United States has shown that for industrial service an instrument actuated by the expansion of nitrogen gas is the most satisfactory for temperature measurements up to 800°F. or 425°C. The gas expansion instrument consists of a bulb of copper which is inserted in the heat, and this bulb is connected by capillary tubing to an indicating or recording gauge containing a helical expansive spring.

The expansion of gas in the bulb exerts a pressure in the capillary tubing, which is conveyed to the spring in the instrument, and the pointer attached directly to this spring moves across the scale or chart. This instrument is not desirable for use where the gauge must be placed more than 100 ft. from the bulb.

For use at moderate temperatures, where the measuring instrument must be placed at a considerable distance, and for temperatures above the range of the gas expansion instrument, the thermoelectric pyrometer has been almost universally adopted in the United States. A thermocouple of base metals, usually formed of one wire of nickel 90 per cent., chromium 10 per cent., and the other wire 98 per cent. nickel and 2 per cent. aluminium, is preferred for temperatures to 1,800°F. or 1,100°C. For temperatures above this, and as high as 2,800°F. or 1,500°C., thermoelectric pyrometers using a platinum-rhodium thermocouple are the most satisfactory.

For measuring the voltage produced by a thermo-couple, whether of base metal, platinum-rhodium or the radiation type, high-resistance milli-voltmeters are available. Such milli-voltmeters are produced by us in the United States, of some 1,000 ohms or more.

The total weight of the moving element in our high resistance pyrometer, including pointer and springs, is 526 mgms. This extreme lightness is secured by the use of an aluminium alloy wire which we have succeeded in enamelling, the enamel coating being much thinner than the silk insulation formerly used.

For even greater precision in temperature measurements than is secured with the high resistance milli-voltmeter, I have developed a new instrument, which we call the brown heat meter. This instrument is suitable for either temperature measurement or automatic control of temperature.

Possible sources of error in the use of a milli-voltmeter in temperature measurement, even one of high resistance, consist in changes in resistance of the circuit comprising the thermocouple and the leads

or wiring, due to changes in length or atmospheric changes in temperature; also errors can occur due to temperature coefficient of the meter—that is, errors caused by atmospheric chages in temperature of the meter itself. Another source of error is a change in the actual indication of the instrument, due to spring fatigue, abuse or sticking, and to overcome these possible sources of error we have developed this rather interesting instrument.

Briefly, its operation is as follows :—

With our standard milli-voltmeter of high resistance, we supply an ordinary dry cell about 1¼ in. in diameter by 2½ in. long, and furnish suitable rheostats to reduce the voltage of the dry cell from approximately 1½ volts to a range from 0 to 60 millivolts, the voltage produced as a maximum by the thermocouples.

In our first operation, we oppose the voltage developed by the thermocouple to the reduced voltage of the dry cell, and when the pointer stands on zero, it indicates that the voltage from each source is equal.

We now in operation No. 2 cut out with a switch the voltage of the thermocouple and read the voltage of the dry-cell circuit by direct deflection. This eliminates the line resistance entirely as in a potentiometer.

We have now a deflection, indicating the actual temperature developed by the thermocouple at the moment of reading the instrument, but fluctuations in temperature of the thermocouple will not be indicated, as we are reading the voltage from the dry cell. We have, however, incorporated other operations in this meter.

In operation No. 3 we connect the thermocouple to the meter instead of the dry-cell circuit, and we note whether the indications are the same. By switching back and forth quickly, the voltage from the thermocouple circuit or from the dry-cell circuit can be noted. If excessive line resistance has caused the indications of the millivoltmeter to be lowered as compared with the dry-cell circuit, a rheostat is operated to bring up the indications of the thermocouple circuit to that shown when we are reading the voltage of the dry-cell circuit.

We now leave the instrument indicating on the thermo couple circuit. The errors, if any, which may be due to line resistance or changes in temperature of the line, have been eliminated, and we have a direct reading millivoltmeter, indicating the correct temperatures.

We have eliminated the temperature coefficient of the meter by furnishing a copper resister in the meter equivalent to the copper or aluminium of the coil; hence in balancing the voltage from the dry cell against that of the thermocouple we also automatically eliminate errors due to the temperature coefficient of the meter itself.

There is now left only one possible source of error, the change in the actual indications of the meter due to sticking of the pointer, abuse of the instrument, spring fatigue, &c. To obviate this source of error, we can supply with the instrument a standard cell with suitable resisters, and in the same manner as the meter can be tested by the potentiometer method we can check the meter.

Automatic Temperature Control.—[illegible] voltmeter, used with the thermoelectric pyrometer, has an exceedingly weak control for the pointer. One is easily able to blow the pointer across the scale with the breath.

[illegible] automatic control work.

[illegible]

Temperature Signalling Pyrometer.—[illegible]

[illegible]

control automatically the furnace temperatures, and the pointer is depressed at intervals of every 10 seconds, on to contacts corresponding to the red, white and green lights.

No special battery or other source of current than an ordinary service line is required to operate these lights. The supply may be 110 or 220 volts, either alternating current or direct current. The current which lights the lamps does not flow through the instrument, but is made and broken by an auxiliary device containing the necessary mechanism. A high resister is in series with the circuit connected with the pyrometer, which reduces the current flowing through the contactors within the instrument to less than 0·07 ampere. This prevents sparking at the contactors and errors due to the heating effect of a current of higher amperage. The lamps may be any reasonable distance from the pyrometer; in fact, they are operative at a mile or more if desired.

The various thermocouples in each furnace are connected successively to the instrument through switching mechanism, and at the same time a switching mechanism connects the various sets of lights at each furnace. We have constructed an instrument of this character to take care automatically of signal lights at twelve furnaces.

[illegible]

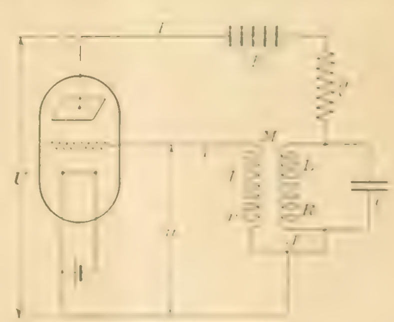
THE AUDION AS AN AUTO-EXCITING GENERATOR.[*]

[illegible]

The problem of the automatic starting of oscillations by the audion is treated analytically, certain necessary conditions being found. Using the letters employed in the figure, the three E.M.F. equations are written down, for the anode, the grid, and the oscillatory (LRC) circuits respectively. Two additional equations, $i=f(U, u)$ and $I=F(U, u)$, representing the characteristics of the audion, determined by experiment, are then added. In order to obtain a solution of these equations the last two are developed in series, of which the first two terms only are taken, thus,

[illegible]

Using the symbolic expression [illegible]



[illegible]

[illegible] grid and filament must [illegible]

[illegible]

* [illegible]

THE PRESSURE REGULATION OF ROTARY CONVERTERS.

BY R. G. JAKEMAN, B.SC.

(Concluded from p. 195.)

Summary.—Two methods of pressure regulation are discussed, (1) by means of reactance and (2) by means of a synchronous booster. (1) The principle of this method is explained shortly and several curves are given, showing values of power-factor and reactance under varying conditions. (2) The principle of the synchronous booster is discussed at length, and vector diagrams are given showing its action under different conditions.

2. Alternating-Current Booster.*

The alternating-current booster consists of a laminated core mounted on the shaft of the rotary converter usually between the slip-rings and the armature. The leads from the slip-rings to the armature winding are then passed through slots in this core and a field system with direct-current excitation having the same number of poles as the converter is arranged round the core. In this way we have a synchronous machine in series with the converter armature. Of course, the leads actually have to make several turns in passing through the booster

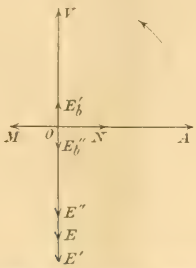


Fig. 12.—Converter with Booster at No-load.

slots in order to obtain the necessary pressure. This synchronous machine then has a two-fold action. If its field is fully excited in the opposite direction to the field of the rotary converter, the booster pressure will be practically in phase with the slip-ring pressure (as will be explained later) and will increase the pressure applied to the converter armature, the booster acting as a generator. If, on the other hand, the booster field is reversed the booster pressure will be practically in opposition to the slip-ring pressure and will decrease the pressure applied to the converter armature. In this case the booster acts as a motor. These actions can best be explained by means of vector diagrams.

If there is no load on the converter the diagram is as shown in Fig. 12. As in Fig. 2, OV is the pressure applied to the slip-rings, OA is the direct-current excitation on the converter field, and OE is the back E.M.F. of the converter, to which the pressure at the commutator is proportional. The M.M.F. of the booster excitation must act in the same straight line as OA because the booster poles are arranged exactly in line with the converter poles.† If corresponding poles on booster and converter are excited in opposite directions, the booster excitation will be represented by OM. This M.M.F., OM, produces a flux in phase with itself which induces an E.M.F. OE_b', in the booster, lagging 90° behind OM and, therefore, in phase with the slip-ring pressure, OV. The back E.M.F. of the converter OE' will therefore be equal and opposite to the vectorial sum of the two E.M.F.s, OV and OE_b' (since the sum of the induced E.M.F.s is zero), and has been increased from its previous value, OE. If the booster excitation be reversed to ON, the E.M.F. OE_b'', induced in the booster will lag 90° behind ON and will now be at 180° to OV. The back E.M.F. of the converter OE'' will again be equal and opposite to the vectorial sum of OV and OE_b'' (which in this case is their arithmetical difference), and has now been reduced from its former value OE.

* [illegible]

† [illegible] Walker, "Specification and Design of Dynamo Electric Machinery," [illegible]

Now let us consider the case when the converter is fully loaded at a leading power-factor, cos φ on the low-tension side. In Fig. 13A, OA again represents the excitation of the converter (which now consists of the combination of the direct-current excitation and the armature reaction due to the wattless current, as shown in Fig. 2), OE' is the back E.M.F. of the converter, and OV the pressure applied to the slip-rings. Let OM be the excitation of the booster-field in the opposite direction to the converter field, OA, and let OI' be the current. The resultant M.M.F. of the booster is represented by OP' and is composed of the direct-current excitation OM and the booster armature-reaction OS', which is in phase with the current OI'. The E.M.F., OE_b', induced in the booster, lags 90° behind OP'. The induced resistance and reactance E.M.F.s in the booster and converter armatures are represented respectively by OR at 180° to the current and OX lagging 90° behind the current. The back E.M.F. of the converter must now be equal and opposite to the vectorial sum of OV, OE_b', OR and OX. Adding OR and OX vectorially to the pressure applied to the slip rings, OV, we obtain OF', and again adding OE_b', the booster E.M.F., vectorially to OF', we obtain OH', where $F'H'$ is equal and parallel to OE_b'. Then OE'', the back E.M.F. of the converter, must be equal and opposite to OH'.

Without the aid of the booster the back E.M.F. of the converter (to which the pressure at the commutator is proportional) would have been practically equal and opposite to the slip-ring pressure, OV. With the booster present, however, the back E.M.F. becomes OE' equal and opposite to OH', and has obviously been increased from its former value. The following points will also be noticed :—OE_b', the E.M.F. induced in the booster, is less than 90° from the current OI', and therefore the

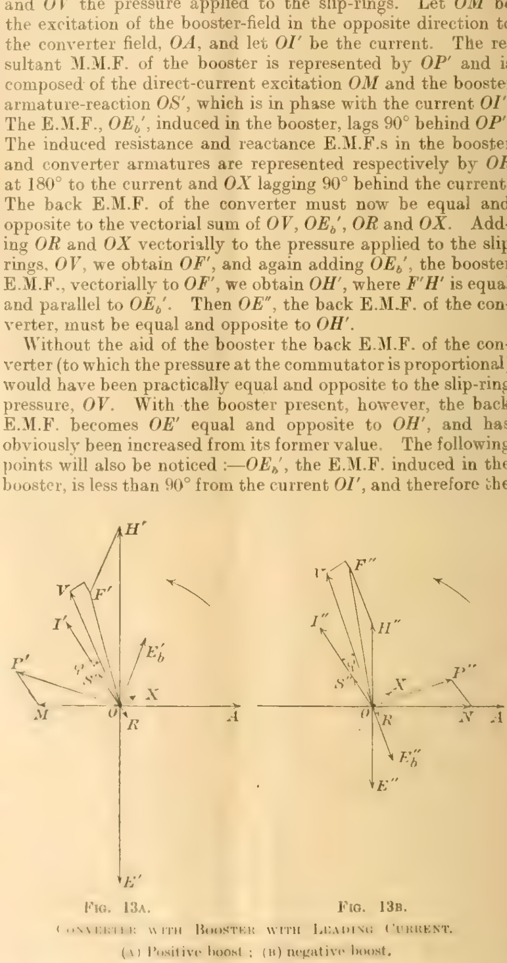


Fig. 13A. Fig. 13B.

Converter with Booster with Leading Current.

(A) Positive boost ; (B) negative boost.

booster is acting as a generator. The current leads the pressure applied to the converter armature by a greater angle than the lead at the slip-rings, and it leads the booster E.M.F. still more. The direct-current excitation must be increased to produce the greater back E.M.F., OE', and must be still further increased to overcome the demagnetising effect of the leading wattless current in the armature. When the booster acts as a generator, part of the electrical energy supplied to the slip-rings is converted into mechanical energy to drive the converter as a synchronous motor and to drive the booster. The latter

portion is reconverted into electrical energy by means of the booster and is supplied in that form to the converter armature, where the conversion takes place from alternating to direct current.

Now let us turn to Fig. 13B, where the booster excitation has been reversed to ON. The power-factor at the slip-rings is still cos φ leading. The resultant M.M.F. of the booster is now OP'', where OS'' is the booster armature reaction and the E.M.F. induced in the booster becomes OE_b'', lagging 90° behind OP''. The induced resistance and reactance E.M.F.s are OR and OX, and adding these vectorially to the slip-ring pressure OV, we obtain OF''. OH'', the vectorial sum of OF'' and OE_b'', must again balance the back E.M.F. of the converter, OE''. It will be seen that OE'' has now been decreased in magnitude from OV to OH'' by means of the booster. The direct-current excitation must be reduced in this case because a smaller back E.M.F. is required, but account must still be taken of the demagnetising effect of the leading wattless current in the armature. In this case the E.M.F. induced in the booster, OE_b'', is displaced more than 90° from the current, OI'', and therefore the booster is working as a motor. Electrical energy is therefore supplied to the booster from the mains, which is converted into mechanical energy and assists to drive the converter as a synchronous motor.

The diagrams in Figs. 14A and 14B are for the case when the current lags behind the slip-ring pressure, OV, by an angle φ. The lettering is the same as for Figs. 13A and 13B. In both

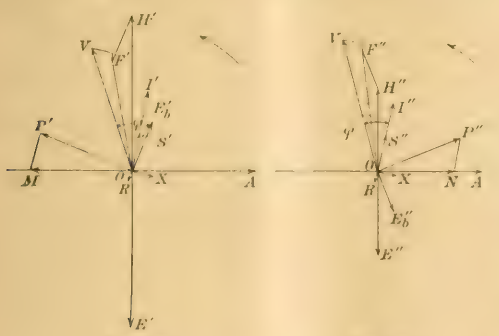


FIG. 14A. FIG. 14B.

CONVERTER WITH BOOSTER WITH LAGGING CURRENT.

(A) Positive boost; (B) negative boost.

these cases the direct current excitation must be reduced on account of the magnetising effect of the lagging wattless current.

When the rotary is running inverted, that is, when it is supplying alternating current, the diagrams become somewhat altered.

In Fig. 15A, OA again represents the M.M.F. of the converter and OE the alternating E.M.F. [illegible] in the armature. OE is, of course, proportional to the pressure at the commutator. Let the power-factor at the slip-rings be cos φ leading, so that the current OI leads by an angle φ the slip-ring pressure OH, which has yet to be determined. If the booster excitation be OM in the opposite direction to the converter excitation OA, the resultant M.M.F. of the booster is OP', where MP' is equal and parallel to the booster armature reaction OS'. The booster E.M.F., OE_b', lags 90° behind OP'. Adding the induced resistance and reactance E.M.F.s to the converter pressure OE [illegible] we obtain OF' and adding OE_b', the booster E.M.F., to OF' we obtain the pressure OH available at [illegible] which balances the back E.M.F. of the load [illegible] OH [illegible] OE, so that the pressure has been reduced from OE to OH. In this case the booster works as a motor. Fig. 15B [illegible] the case when the booster is excited in the same direction as the converter and [illegible] that the pressure is increased [illegible] OH to

OH'', while the booster acts as a generator. The diagrams for a lagging current are similar to the above.

The next point to be considered is the case when there is no direct-current excitation on the booster. We shall assume for the moment that the booster field-system is of the cylindrical type, so that the magnetic reluctance is the same at all points on the periphery. The only excitation now on the booster is that produced by the armature reaction and the diagram is altered to Fig. 16. The armature reaction, OS, is in phase

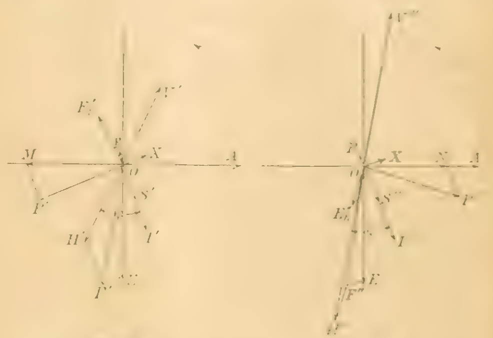


FIG. 15A. FIG. 15B.

CONVERTER WITH BOOSTER, RUNNING INVERTED WITH LEADING CURRENT.

(A) Negative boost; (B) positive boost.

with the current, but is at a considerable angle to the field M.M.F. vector, that is, it acts between the poles. Since, however, the reluctance is the same at all points of the periphery this armature reaction will have just as much magnetising effect as the same excitation on the poles. Hence the E.M.F., OE_b, will be induced.

From this it is clear that as the booster field current is changed from a maximum in one direction to a maximum in the other, the booster pressure does not fall to zero, but from being nearly in phase with the main pressure it changes its phase until it is nearly in opposition to the same. At the same

FIG. 16. [illegible]

[illegible] M.M.F. [illegible]

We [illegible]

[illegible]

Ne[illegible] M.M.F. [illegible]
E.M.F. [illegible]

At full voltage the armature reaction, which is in phase with the current, is comparatively small with regard to the direct-current excitation on the poles, and the M.M.F. diagram is shown in Fig. 17a, where OB is the M.M.F. of the direct-current excitation, AB the armature reaction and OA the resultant M.M.F. This is shown diagrammatically in Fig. 17b. OB, the direct-current excitation, acts in the centre of the pole, OA, the resultant M.M.F., is at an angle α to OB, and AB, the armature reaction, at an angle $(90°-\varphi)$ to OA, and therefore practically midway between the poles. Now considering the direct-current excitation reduced to a small value the diagram becomes that in Fig. 18a, and turning to Fig. 18b we see that the armature reaction, $A'B'$, now passes practically through the centre of the pole. Hence, in an ordinary syn-

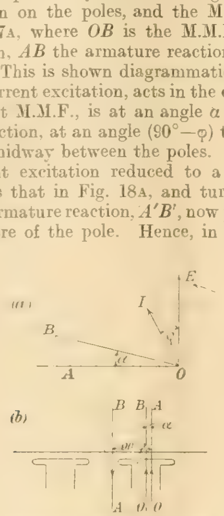


Fig. 17 (a and b).—Diagrams of Alternator with Full Voltage and Leading Current.

chronous generator or motor, the position of the armature reaction moves with regard to the poles for different relations of flux and current.

With the booster, however, the conditions are quite different. For a given power-factor the angle between the vectors of current and converter E.M.F. is approximately constant and hence the direction of the booster armature reaction is fixed with regard to the converter poles, since, as was shown above, the converter E.M.F. vector is fixed with regard to the poles. Therefore the booster armature reaction is also fixed with regard to the booster poles since these are arranged in line with each other. Hence it is clear that with unity power factor the booster armature reaction always acts approximately midway

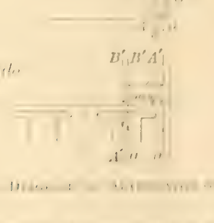


Fig. 18 (a and b).—Diagrams of Alternator with Short-circuit.

between the poles, while the resultant M.M.F. moves from [illegible] of one pole with [illegible] excitation, to one [illegible] the centre of the next pole with maximum [illegible].

[illegible] to Fig. 16, and [illegible] a salient pole machine, the E.M.F. OE will be very much reduced from what would obtain with a booster with a cylindrical field, owing to the increased reluctance between the poles. Since, however, [illegible] the effect of OE on OH is very small indeed and OH is practically equal to OF, the magnitude of OE is quite unimportant. Hence the arguments are not affected by the shape of the field system.

I am deeply indebted to Dr. S. P. Smith and Mr. W. W. Wood for their valuable criticism and suggestions.

MR. R. HOWARD FLETCHER'S ADDRESS TO THE WESTERN LOCAL SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.*

Once again it is our lot to meet for the opening of a new Session with all our thoughts dominated by war. Under such conditions it is practically impossible to avoid the subject, however much one would wish to do so, and I have therefore decided to touch upon a few points more or less connected with our own industry, which have been directly or indirectly brought into prominence by this gigantic struggle.

An enormous amount of matter has been spoken and written on the question of scientific and technical research, but even now there appears to be a most extraordinary confusion in the minds of many people between purely scientific and technical research. There is, of course, no doubt whatever that the closest possible co-ordination between science and practice is essential to progress, and we have reason for high hopes that this will to a very great extent be brought about through the efforts of the Imperial Trust for the encouragement of such research. It may seem rather extraordinary, but it is nevertheless a well-established fact that it is very rarely the case that a single brain is alone engaged on any particular problem, however abstruse that problem may be. If a problem is being worked out in one works it is by no means improbable that some other man in some other works is engaged on the same problem and, supposing that he too has some measure of success, the effect is likely to be the same in both works, with the result that a cut-throat competition is started between these two rivals. The consequences are obvious; nobody profits to any extent; other competitors are squeezed out, and it is quite on the cards that a more complete solution may be found at smaller cost in some other country where knowledge is better co-ordinated, and thus this particular industry gradually dies down and is finally lost to the nation. We can only hope that some satisfactory means may be found which shall overcome this difficulty, for it is undoubtedly a very real one.

I do not think that it is the smallest exaggeration to say that the loss or absence of any industry is a very serious matter, and where the particular industry is of vital importance in an emergency it might well prove to be national disaster.

The reason why industries are lost is that in this country practically everything of an industrial nature has hitherto been left entirely to private enterprise, whereas in foreign countries the Government have very effectively assisted and financially supported the establishment of new industries on a scale which would have been far beyond the means of private enterprise, and still more beyond its capacity for taking the necessary risks. Fortunately, those in authority appear now to be keenly alive to the importance of this matter, and it is to be hoped that no time will be lost in taking the necessary steps to insure that as far as is possible we shall in future be in a position of self-contained independence as regards both indispensable materials and the industries dependent upon them.

It is quite impossible to over-estimate the importance of Government assistance in such questions as wayleaves, as, unless a really cheap supply of power is made available, our industries will be quite unable to hold their own in the period of commercial stress which will undoubtedly commence immediately after the war. The task awaiting all engineering companies, and particularly electrical companies, will be enormous. The war has emphasised the importance of the electric drive. Then again, there are many purposes for which the use of electricity is growing very rapidly. The increase in the use of the electrical steel furnace is most striking when you consider the former prejudice against it, and it has been amply proved that high quality steel castings made by this method are distinctly superior to those made by any other process. The electric furnace is also being largely employed in the production of the highest grade tool steel and the special alloy steels used in aircraft manufacture. Its many advantages, including a very considerable reduction in melting losses and the ability to use second grade materials in the manufacture of high class steel are at last fully recognised, and there is no doubt that its use for such purposes is now firmly established on merit. There are, of course, many other applications of the electric furnace, such as the fixation of nitrogen, which seems likely to develop into a considerable industry. Steps are being taken in many directions to establish electro-chemical works for various purposes. Then we have electro-culture, which is receiving a large amount of attention at the present time. The war has taught us that farmers are quite as valuable as bankers or manufacturers, and they should receive every encouragement

* Abstract.

and assistance, and if, as seems probable, electro-culture should be found to render the farmer more independent of the weather, in addition to increasing his crops, it will be an enormous gain to the community, not only from the food point of view, but also from the fact that it will help to keep money in the country and free more shipping for those essential raw materials which are not obtainable in this country. This particular application of electricity will not in itself mean a large demand for power, but it should nevertheless be of value to the station engineer as a means of introductions to a class of consumer who has many uses for power which hitherto he has only been able to obtain by costly and wasteful means. Incidentally also it should be a useful assistance in the obtaining of wayleaves in country districts as even what I can only term the natural cussedness of the landowner, is likely to be considerably modified where prospective benefits are to be obtained by the granting of a wayleave.

It is probably owing to their undoubted thoroughness that so many people in this country appear to think that Germany has a sort of monopoly in the power of organisation, but we have only to consider how quickly and efficiently our workshops and factories were adapted without any warning to the production of munitions of war in order to negative that theory once and for all. A very great deal has already been done towards the attainment of these ends, but an enormous amount still remains and it cannot be done too carefully or too quickly.

Before leaving this subject there is one point with regard to organisation in industry which is, I think, of some importance. Any thorough organisation implies a more or less high degree of specialisation if it is to be really efficient, but there is always the danger that specialisation may be carried too far. As a nation we undoubtedly possess a very marked individuality, and it would, in my opinion, be a very serious misfortune if this characteristic should become atrophied by condemning our youth to enter a narrow groove at an early age.

Now in all this remodelling of the industrial edifice with its main objects of increased production and maintenance of quality in the product, there are, of course, many problems to be solved, but the majority of these almost pale into insignificance as compared with the question of the existing relations between employers and employed. The prime necessity in dealing with this problem is to find some means of removing the feeling of mutual suspicion and distrust which at present characterise their negotiations and are, in reality, the foundations of all the trouble. You have doubtless all read what is known as the "Whitley Report," with its suggestion for the formation of a series of Trade and Industrial Councils, composed of members of Trade Unions and Employers Federations. In principle, such a system, though somewhat cumbrous, is, of course, perfectly sound, but I think it is obvious that it cannot be a practical success unless these two requirements are fulfilled. First, it must be thoroughly understood and fully appreciated by all parties concerned that the object of this machinery is not to settle disputes, but rather to remove at its source any cause which might lead to a dispute if allowed to continue and to enable all parties to work amicably together for the advancement of their particular industry to a high degree of prosperity with the necessary [illegible] to ensure that all parties [illegible] an equitable share in the benefits resulting from such prosperity. The other essential requirement is that every member of such Council shall be a real and accredited representative of his particular body, and I firmly believe that if the question of representation can be satisfactorily solved, [illegible]

[illegible] Trade Unions [illegible] of employers [illegible]

of his subject is very superficial, and who probably knows nothing of the complicated nature or cost of distribution and sale. Such a man is invariably suspicious. Now it is fairly certain that the arguments put forward by a man of this type for election purposes will never have been really convincing, and he will not have succeeded in imbuing his supporters with a very deep faith in his knowledge and judgment, and, moreover, he has become an object of some envy owing to his now having comparatively light and congenial work, greater freedom, better pay, and, as I believe, most desirable of all, an improved social position. Under such conditions, he will soon begin to lose touch and it only needs the coming of an agitator with perhaps a more glib tongue or more fiery eloquence, and the so-called representative is finally discredited. I hope you will not think that I have laboured this point unduly, or that the cause I have suggested is too small to deserve notice, for it undoubtedly exists and has its influence, even if it has not the weight which I have attributed to it.

HYDRO-ELECTRIC POWER IN ONTARIO.

For some time the policy of the Hydro-Electric Power Commission of Ontario has been criticised by financiers and engineers in the Dominion and the United States of America, principally because the Commission desires to generate as well as to distribute power. Some of this criticism, which is probably inspired by rival generating companies, is scarcely calculated to assist electrical progress.

In a recent issue of the [illegible] it is stated that the President of the Commission, Sir Adam Beck, now proposes to change the Hydro-Electric Commission from a mere distributing company to a generating company, and supply power [illegible] but to corporations and individuals in Ontario and [illegible] boundary in the United States. The Commission [illegible] the Ontario Power Co., which is generating 140,000 H.P. Besides owning transmission lines in the Province of Ontario, [illegible] owner of transmission lines in New York State, and [illegible] Rochester, Syracuse, Utica, Lockport, Niagara Falls, [illegible] The Commission is thus in competition with the generating companies in Niagara, and is subject to the laws of the United States and of the Dominion of Canada regarding the export [illegible] The Commission bought the Ontario Power Co. because they were short of power, and it could [illegible] power" which Sir Adam Beck [illegible] he created a false [illegible] power to go round." [illegible] in the meantime he bought the only plant he could. The shortage still exists, because all of the power generated has been sold. Between 40,000 H.P. and 50,000 H.P. is [illegible] United States. The balance is already taken [illegible] Canadian consumers of the [illegible] Commission now wants [illegible] Canadian Niagara [illegible] on the Canadian side of the Niagara River [illegible] British capital, and the [illegible] American [illegible]

[illegible] and the Hydro [illegible]

[illegible] right to commence litigation [illegible]

Metric System and Daylight Saving Measures. [illegible]

[illegible] April [illegible] South African [illegible]

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A NEW INSTITUTION OF ELECTRICAL ENGINEERS.

Last week Mr. C. H. WORDINGHAM, the new President of the Institution of Electrical Engineers, gave an inspiriting address at the opening meeting of the session. The address was largely concerned with what he considered should be the future policy and scope of the Institution, and it must have left his audience with the view, already well established, that he is a man of vigour and action.

Mr. WORDINGHAM referred to the views so often expressed or implied that every new member of Council with ideas of reform very soon loses such ideas after joining the Council, and that the Institution is run merely by and for the London members. Such ideas, he remarked, were largely fostered by the fact that the deliberations of the Council were not published. It had been suggested from time to time that the work of the Council should be published, but this was rendered impracticable owing to its confidential nature. Thus Mr. WORDINGHAM can only personally assure us (and we fully accept this assurance) that possible reforms are not disregarded (as witness the recent exclusion of alien members and the introduction of proxy voting) and that the London members have no desire to run the Institution merely for their own benefit. In fact, every care is taken to avoid any such policy.

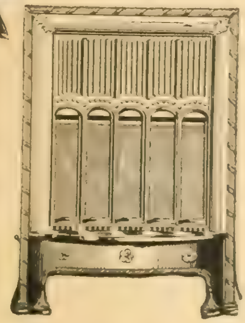
Mr. WORDINGHAM touched upon the question of the Institution playing a larger part in commercial matters. As a foundation-stone we are glad to find he took the sound view that the Council cannot act in the interests of any particular section. In other words, commercial matters relating to the welfare of any section of the industry cannot, generally speaking, be dealt with by the Institution. The view was expressed, which we feel is correct, that every section of the industry should organise to protect their own particular interests; by so doing, a homogeneous body for any section is obtained having undivided interests, whereas in the Institution, which represents all sections of the electrical industry, the interests must at times be conflicting. On the other hand, it is most desirable that all sections should be thoroughly represented on the Council of the Institution. Here Mr. WORDINGHAM touched on a point which we have often felt is a source of weakness, namely, that under present conditions the representation on the Council is liable to be out of balance. In other words, a section of the industry which, although important, does not appeal particularly to the membership at large, suffers through not being sufficiently represented. It is difficult to overcome this defect when election depends upon voting by the whole body of members. The suggestion [illegible] by Mr. WORDINGHAM is that each section should elect [illegible] number of members to the Council. At present not only is the voting inefficient, as only about [illegible] per cent. of the members vote, but it is also not sufficiently discriminating.

Another subject on which Mr. WORDINGHAM touched was the lack of sociability in the Institution building. Undoubtedly the Institution does not correspond in this respect with the Engineers' Club of Manchester. On the other hand, we feel that this is not merely the fault of the Institution, but rather of London itself, which is comparatively unsociable, largely, we believe, because it is so extensive compared with any provincial city. We are inclined to doubt, even with the best will in the world, whether an engineers' club in London would be as successful as the Engineers' Club in Manchester. Nevertheless, we think something more might be done to make the Institution building, when once it is regained, a place of meeting not only for the membership as a whole but for members individually. Facilities for light refreshment would be a necessary change, but we believe there is some financial difficulty in taking this step.

As regards the character of the meetings themselves there is a good deal of truth in Mr. WORDINGHAM's view that they are rather forbidding, more particularly to the younger members. One realises this fact by contrast if one attends a meeting of a Local Section. A meeting at any of the provincial cities is undoubtedly less formal, but this is largely because the meetings are much smaller and because practically everybody knows everybody else. It is this last fact which contributes so much to the lack of formality. We think it would be an advantage to have informal discussions as suggested by Mr. WORDINGHAM, but formality is not killed merely by calling a meeting "informal," and will probably remain if the meetings reach any considerable size. We venture to think that if an informal meeting were restricted to, say, an attendance of 100 and the President and Council were abolished for the occasion (if we may suggest such an unorthodox course), the junior member would feel much more inclined to talk than under ordinary conditions.

Mr. WORDINGHAM expressed the hope that one day the Institution would be a thoroughly representative body, embracing all sections of the electrical industry and provided with a Royal Charter, the object being to place the Institution on the same level as the General Medical Council and the Incorporated Law Society. In other words, membership would then involve certain qualifications, and without membership no one would be permitted to practise as an electrical engineer. The Institution would then be the only body recognised by the Government as representing electrical engineering, and each association formed for the purpose of safeguarding the commercial interests of any section would be represented on the Council. Actually, however, we believe that the course is not quite so simple. A Royal Charter gives certain privileges; it would prevent any person calling himself a member without actually being so; but the full powers desired by Mr. WORDINGHAM can only be obtained by an Act of Parliament subsequent to a Royal Charter. It is well to remember that in such a matter it would be necessary for the Institution to act in co-operation with the Institutions of Civil and Mechanical Engineers. So far, the branches of engineering represented by these two Institutions have progressed (we think we may say satisfactorily) without such powers, and consequently such action as is suggested might be thought unnecessary and might even be opposed. Undoubtedly, if these powers were obtained by the Institution electrical engineering would be in a very different position from what it is now, because not merely would the standard of those practising be higher, but standards of work could be enforced.

The programme outlined by Mr. WORDINGHAM is ambitious; it is certainly too large to be accomplished within his term of office, particularly under present conditions; but it is well that he should set up these ideals before us so that the Council may strive to attain thereto.



MR. C. H. WORDINGHAM'S PRESIDENTIAL ADDRESS TO THE INSTITUTION OF ELECTRICAL ENGINEERS.*

It is not unusual for a president to take for the main theme of his address a subject of which he has some special experience, and the fact that my work during the last 14 years has been in connection with a unique application of electrical engineering, namely, the equipment of ships of war, would seem to indicate that I should follow this course and describe to you the peculiar difficulties attending such work, and the means taken to overcome them. Owing to the fact, however, that we are at present in a state of war there is much that it would be inexpedient for me to mention, so that my account would necessarily be incomplete, and I have decided, therefore, not to follow this course, though I hope at some future time it may be possible to bring this section of my experience before you in some other form in more peaceful times.

I propose to take for the main subject of my address this evening the Institution itself. The Institution and the industry should be one, and if they are not it is our business to make them so. There are great problems before us, some present now and some that will confront us in the immediate future, and it will need the fullest co-operation and unanimity on our part as to the action necessary to enable them to be solved satisfactorily.

THE INSTITUTION AS NOW CONSTITUTED.

I will first address myself to a consideration of the Institution as at present constituted. I have seen from time to time, with great regret, indications that many members are not wholly satisfied with the management of the Institution, and have heard expressions of opinion that it does not sufficiently represent the industry or look after its interests adequately. These allegations are, in many instances, based upon ignorance of what the Council is doing, but more largely upon a want of appreciation of what it is possible for the Council to do. It should never be forgotten that the Institution comprises in its members every electrical interest in the country. I have always held the view that the Institution should attend to the promotion of electrical science and its applications to engineering; but it should not attempt to look after the commercial interests of any one section. It is often stated, in a somewhat sneering manner, that the Institution will not demean itself by looking after such sordid considerations as those involved in commercial pursuits.

No greater misrepresentation of the attitude of mind of those who see the limitations could be made. The reason that I contend the Institution should not attempt to interfere with commercial matters is that it is impossible for it to do so efficiently. It is of the essence of the successful prosecution of commercial interests that those interests should be common and homogeneous, and I have always held most strongly that each section should organise its own association for the promotion of such interests so as to bring the greatest possible weight to bear by concentrating the whole action in one direction.

I believe also that much apprehension arises from the fact that the proceedings of the Council are secret. Much of the matter which comes before the Council is of necessity confidential, and cannot be published. The only possible course is for members to trust those of their number whom they have elected to the Council, and to believe that they are doing their best to [illegible] the good of the Institution and watch over the interests of its members.

This brings me to the very vital question of [illegible] of the members in the Council. It is an unfortunate fact that a very large number of members abstain from voting at the Council elections. I should like to see some change made in the mode of the election which would ensure that each [illegible] directly represented thereon in proportion to the [illegible]. In addition, I would have a certain number [illegible] of members [illegible]

Yet another matter [illegible] feeling that London members [illegible] living outside London and abroad. [illegible] and the [illegible] [illegible] geographical position. It is of the utmost [illegible] of the Institution that any [illegible] should be [illegible] be done.

WORK IN LONDON.

Turning now to London [illegible] whether the Institution is doing all that it can [illegible] object. Many members think [illegible] and I am afraid there is some ground for their doubt. [illegible] ordinary success of such an institution as the Manchester Engineers' Club in bringing together so many different kinds of people interested in engineering and in initiating useful schemes for the good of the industry, one cannot help asking oneself why it is that something of the sort cannot be done and done on a far larger scale by the Institution. Even country members are often in London, and they would soon flock to the Institution if they knew they would meet there the men they want to see.

SUGGESTED NEW FEATURES.

I think short informal meetings, at which points of difficulty or special and immediate interest could be discussed in a more or less conversational manner would be of great utility. Often a burning question arises, frequently at short notice, and it would be of inestimable benefit if the matter could be thrashed out at a meeting at which everybody concerned would be able to put forward his views and hear what his neighbours thought about the matter. Such meetings would encourage the younger members to come forward. I am confident that the progress of the Institution will be greatly helped by interesting the younger members in its doings, and every possible means should be taken to effect this end. Draft specifications, rules, &c., might be discussed, and more intimate matters affecting the management of the Institution itself might often be talked over with advantage. Were such an opportunity available many subjects would arise for discussion.

It would be of extreme value if the Institution were to arrange for a series of lectures on special subjects by experts in those subjects, setting forth what has been accomplished in the particular branch concerned and giving a general idea of the present position of knowledge. For example, electric furnaces have developed to an extraordinary extent during the last few years; electrical theory has undergone many modifications and much development; a practically new field in electrical cultivation is being opened up, and many other examples will suggest themselves.

Again, I should like to see something done with a view to interesting the enormous army of men not qualified to become members in any grade of the Institution, but on whom much of the welfare of the industry depends. I refer to the workmen class. It should be possible to awaken in these men, many of whom are exceedingly intelligent, a desire for a better knowledge of the principles underlying their work.

The Institution might also with advantage come out of its shell and cater for the education of the general public in electrical matters. Popular lectures on the lines so successfully followed by the Society of Arts and the Royal Institution [illegible] elementary knowledge of electrical subjects and to make the public realise the advantages of electrical appliances.

This branch of the work might be supplemented by a carefully organised permanent exhibition [illegible] constantly changed [illegible] It ought to be a [illegible] electrical invention [illegible] a matter of course [illegible]

From time to time [illegible] those given by the Royal [illegible] monthly [illegible]

[illegible] have indicated.

[illegible]

The position in regard to the promulgation of rules regulating electrical practice in essential particulars is most unsatisfactory. The Institution has drawn up such rules, but can give them no mandatory force. Although an immense amount of work has been done in preparing standards no power whatever exists to enforce them, and in the absence of compulsion, which would put all manufacturers on an equal footing, firms who would gladly comply with the requirements hesitate to incur the expenditure necessary to bring their practice into line with them, while others, taking a narrow and short-sighted view, deliberately refuse to adopt them. The result is that the cost of manufacture is unnecessarily high and users suffer inconvenience from the diversity of practice, the spread of the use of electrical appliances being retarded in consequence.

I am aware that there are serious difficulties in giving effect to the views I have enunciated. In the first place, electrical engineers, though they touch at one point or another the work of almost every other class of engineer, are but one of several important groups. It is difficult for one section of engineers to obtain powers not sought by other sections, and unquestionably our efforts ought first to be devoted to carrying with us those other bodies, such as the Institution of Mechanical Engineers, the Institution of Naval Architects, and more especially that mother of institutions, the Institution of Civil Engineers. Engineering in the widest sense would then be placed on the same footing as other professions, and be similarly recognised by Government.

In seeking for powers such as I have indicated I do not wish it to be understood that I think they should all necessarily be vested entirely in the Institution. The powers relating to the entry and continuance in the profession should certainly be granted to the Institution, but the rules for regulating engineering practice and standards may well require some collateral Government action to give them force after the Institution has formulated them.

Electrical differs from all other kinds of engineering in the extraordinary variety of the operations included in the general term. No other institution has so many and such varied interests to represent, nor has any other profession need for anything approaching the elasticity as to the qualifications to be demanded of those entering its ranks as our own. It is for these reasons, probably, in large measure that the present unsatisfactory state of affairs has arisen, but the difficulty of the problem only makes its solution the more imperative.

Owing to the importance of certain sections, influential bodies outside the Institution have grown up. It is eminently right and proper that they should be formed. It is, however, equally important that there should be no overlapping. I deprecate most strongly anything in the nature of rivalry. The ideal that I look forward to is a strong Institution, endowed with a Royal Charter, recognised as the embodiment of the whole industry as far as those outside it are concerned, invested with full powers as to the educational qualifications to be possessed by all grades of workers in the profession and industry from the highest to the lowest, and effecting under its ægis the federation of all other associations connected with the multifarious branches of electrical work.

I may here point out that we cannot expect more than one body to be recognised by the Government and the public as standing for the electrical industry.

It would be futile to attempt to enter into any detail here. Broadly, my view is that each section should have its own association to look after its commercial interests, such association being formed if not already existent for a particular branch, and that each should be represented directly in appropriate proportions on the Institution's governing body. The Institution to be given a definite status by the Government and recognised as the only body representing electrical engineering; the Institution to control entry into the profession, and all regulations on electrical matters to be issued at its instigation or in accordance with its advice. Grants in aid of research or other national purposes to be entrusted to the Institution for administration.

RESEARCH.

One of the most important matters demanding attention is research [illegible] pursued.

[illegible]

[illegible]

inventions he may make. Such co-operation must tend to give far better results than any independent efforts of one class of worker without the other. With the National Physical Laboratory and laboratories at universities and technical colleges ample provision would be made for this class of research.

Industrial research stands on a very different footing in every way. To begin with, the objects in view of the worker differ fundamentally. This fundamental difference in the objects of the workers involves important considerations in the promotion of research out of national funds. If industrial research is to be of real value to the nation it is essential that much of the work done shall be kept secret and only imparted to those who will directly utilise the information obtained for the benefit of British trade.

Industrial research bristles with difficulties, not the least being the problem of the ownership and patenting of new discoveries or processes.

Industrial differs from purely scientific research also in the scale and in consequence the cost of experiment. There is a crying need for the establishment of one or more fully equipped laboratories on a large scale for the investigation of industrial problems. Such laboratories will need the generous support of the Government and the manufacturers. Without setting up the gigantic monopolistic concerns of other countries we can secure results as good as, and probably better than, they by the co-operation of our smaller companies in which individual initiative and ability have greater play.

It may be well here to point out that research alone will not suffice to ensure industrial progress in this country, however extensive the facilities that may be provided. In point of fact much research and many discoveries have taken place here in spite of the unfavourable conditions. It is necessary also to give the discoverers and inventors in this country the necessary financial support.

A consideration of laboratories leads me to the establishment of an institution which shall be in a position to say authoritatively whether certain standards have been complied with and to give a hall-mark to British manufactures. It has long been a cherished ambition of mine to see established such an institution for which I have suggested the name of National Electrical Proving House. Since the war, the reality of the need which I first pointed out 18 years ago has been appreciated, and there is clear indication that the proposal commends itself to manufacturers and, with a courtesy and consideration which I highly appreciate, members of the B.E.A.M.A. have asked me to bring the matter forward at the Institution during my year of office. A committee of the Council has already been instructed to report on the matter, and they have recommended the setting up of a committee representing the interests concerned. When this committee has drafted outline proposals an opportunity will be given for the matter to be fully discussed by the general body of members, after which I hope that definite and adequate steps may be taken before the close of the session to set up an authority which shall be able to certify whether an article is or is not in conformity with a given standard of excellence, and shall give it a hall-mark which shall be recognised throughout the world as a guarantee of British origin and British excellence and reliability.

INFLUENCE OF THE WAR.

In regard to the furtherance of trade I will only remark that efforts should be directed towards assisting industries and not be employed in interfering with them. It is the proper function, however, of Government to utilise the power of compulsion vested in it in order to ensure that impartial justice is done and that no one section of the community, however powerful by riches or numbers, oppresses any other. The chief ways in which Government can assist industry are the safeguarding of British interests abroad, so that the British trader may be at least on an equal footing with those of other nationalities in foreign markets; the shielding of young industries; the conservation of natural products of the Empire; the removal of all obstructive and injurious legislation; and, finally, the collection of really useful information as to foreign markets not available to traders by their own unaided efforts and its dissemination without delay among those concerned.

Although there are ways in which the Government can help, and help effectually, it must receive guidance from the industry as to what is required and it is from the industry itself that the initiative and the main portion of the work in securing success must come. In deliberating upon the action to be taken, every effort must be [illegible] weight to each consideration, and to avoid turning [illegible] principle eminently true and valuable into a shibboleth and pushing it to such an extent that in place of being beneficial, it becomes mis[illegible] I believe the keynote of our success in the future should be co-operation and federation. Our motto should be that of the [illegible] each for all and all for each.

Believing, as I do, most fully in the combination that I have advocated, I would indicate the danger arising from making it into

a shibboleth. While it is imperative that combination should be effected among manufacturers for the promotion of the Empire's world trade, in combining let us not forget it is the individualism of the Briton which has brought him into the position that he occupies in the world. I venture to think that too little appreciation has been evinced of this position.

There is one danger to our trade which I greatly fear, and which will be realised unless we as individuals can rise above our own selfish immediate apparent interests, and can consider the good of the nation as a whole. Let every man who is tempted, as he will be tempted, and tempted very strongly, in the near future to fall back into his old reliance on German produce remember that in yielding on account of what appears to him to be his immediate commercial advantage he is showing himself to be a traitor to his country, and is ultimately assisting in his own downfall. If this nation is to survive in the industrial war on which we must shortly enter, it can only do so by recognising its enemies and by its individuals holding together and supporting each other's efforts for the common welfare.

(To be continued.)

PATENT LAW REFORM.

In a Paper before the London Section of the Society of Chemical Industry on Monday, November 5th, Dr. F. W. Hay, of British Dyes (Ltd.), outlined a number of ways in which he suggested the patent law of the country could be improved in order to give a greater measure of security to inventors. The present system of search for a period of 50 years on the part of the Patent Office, in order to ascertain whether there has been anticipation, he regarded as insufficient, as it only applied to prior British patents. He was convinced that this was a weakness which had prevented our patent laws from exercising their full beneficial effect, as the position was that the public could have no faith in a patent until the law courts had examined it and declared it to contain a new invention. Unless the scope of examination was considerably enlarged the result would always be unsatisfactory. He admitted that an extended search would need a greatly increased staff at the Patent Office and increased expenditure, but the country could afford to spend money upon its Patent Office instead of making it a source of revenue as at present. Coupled with this extended search there should be the right of appeal to an appeal board, comprising the Comptroller or his delegate and three experts engaged in the industry to which the invention relates, the Comptroller having a casting vote when the voting was equal. Finally, there should be an appeal to the High Courts if an applicant did not think his case had been fairly dealt with. A further supplementary control was necessary in regard to patents relating to the chemical industry. Engineering patents could be verified by the drawings, but not so with chemical manufacture. German patentees had obtained patents which were drowned in a mass of more or less plausible statements intended to obscure the patent. It would be advisable to provide a suitable laboratory for the testing of chemical inventions when the examiner was in doubt as to the veracity of the statements made. The examiner in chief should be entitled to [illegible] the application in the light of the result of the test, subject to an appeal to the Appeal Board. In the matter of chemical patents, the Swiss system might be borne in mind. There it was the custom to tie the inventor down to a description of one particular and clearly defined process, and not to allow claims for general methods or broad ideas. He also proposed a period of five years after which a patent could not be attacked for want of novelty. If this were done it would be impossible for a wealthy company to intimidate an inventor that his invention was not valid or that they possessed prior patents. At present there was no remedy for this except to go to court. A revision of court procedure was also necessary. At present many a manufacturer was deterred from taking up a new invention because he felt that infringers were bound to turn up and [illegible] the expense he had gone to more or less valueless or that he would be put to great expense in fighting them. Others, on the other hand, preferred to put up with a certain amount of infringement rather than run the risk of costs in a legal action. In the chemical industry the situation was particularly bad. Judges often had to form a judgment upon chemical matters of which they had but a rudimentary knowledge, and were compelled to depend upon the testimony of expert witnesses. To aid in improving this state of affairs Dr. Hay suggested a jury of technical men, in the same way that a [illegible] or common jury is now employed in ordinary legal actions. [illegible], he suggested, would reduce the cost and the uncertainty which [illegible] to judicial incompetence in technical matters, judges frequently confessing their diffidence in expressing an opinion upon highly technical matters such as those concerned with chemistry.

DISCUSSION.

Mr. WALTER F. REDDAWAY [illegible] a jury of [illegible] was suggested, [illegible] feel that such an alteration [illegible] system would have any advantage. Many an invention [illegible] dormant for years [illegible] application eventually. He himself had a patent which was turned down a few years ago, [illegible]. It would pay the [illegible] out of the public purse, as every invention was [illegible], and it was only by making fresh inventions that we could [illegible] among the nations of the world. He [illegible] present [illegible] failure, but was doubtful whether the [illegible] American system would improve matters. In [illegible]. He was also doubtful as to the expediency of a testing laboratory [illegible] by the author.

Mr. ARNOLD PHILIP said he would prefer the French system of getting a patent merely by paying the fee, and then fighting for it in the courts afterwards, if necessary, coupled with the American system of one fee and no renewal fees. A patent might be upset by a book and not by a prior specification.

Mr. J. W. GORDON, K.C., said that although there were difficulties in the way of Dr. Hay's suggestion for a technical jury, he thought they could be overcome. It might be preferable to have men on such a jury who did not belong to the particular industry concerned in the patent that was to come before them. In a chemical case, for instance, they might have engineers, metallurgists and geologists, and such a jury might exercise a beneficial control over the expert evidence in that they could elucidate matters which a judge alone might not be able to do. There would be a disadvantage in entrusting a case to a jury who could follow it independently of the evidence. One thing that should not be lost sight of in dealing with patent law reform was that the Colonies followed closely everything that we did in England, and some of the suggestions that had been made might make the position of the inventor worse if they were at the same time applied in the Colonies. What he would like to see was a unified Imperial British patent system, and that might be kept in view by the society before it committed itself to any definite scheme of reform.

Mr. JAQUES ABADY said that in proportion as a patent was simple so was it likely to be less the subject of infringement. The extended search he did not think would be an improvement because it was not always prior specifications that were cited as anticipations, and it was for the inventor to look after himself more in this respect because there were ample facilities for search at his disposal. He failed to see a difference between a jury as defined by Mr. Gordon and a judge as at present. The close time for patents suggested by Dr. Hay did not seem to meet the case, because it was surely during the first five years that the patentee required protection, during the time he was getting his commercial organisation together.

Mr. P. C. H. WEST agreed with previous speakers as to the value to be placed upon the so-called extended search in America and Germany, and reminded those who favoured a change from the present British system that an extended search did not reduce the number of possible actions for infringement. He did not agree that it was possible [illegible] theoretical matter in this country. A man might patent a process for making a certain chemical which would give a yield of [illegible] per cent., but this did not prevent another man who had made extensive investigations from getting a patent for a process which would give a yield of [illegible] per cent. He feared to contemplate the results of setting up a Government laboratory to test chemical inventions, and it was the [illegible] that must go to the wall. Neither did he favour the jury system, and was quite satisfied with the present system, in which, on the whole, judges decided fairly.

Mr. PEARSON suggested the formation of committees by the various industries interested in patent law reform, which should decide the extent of the modification of the law which was desired. When these committees had completed their work a larger committee should be formed of representatives of the various industries which would draw up a complete scheme of amendment to be submitted to Parliament.

Dr. DEHN agreed that [illegible] conclusions and pointed to the danger of [illegible] constituting a jury, adopting a half-way course and giving a decision which was satisfactory to neither party.

Dr. HAY [illegible] from the [illegible] that [illegible] a sub-committee to examine the question.

Commercial Electrolytic Iron. According to the "Scientific American," a French firm [illegible] has been successful in producing iron electrolytically on a large scale, and [illegible] are said to have already applied this iron to the making of [illegible] from [illegible]. These [illegible] suitable [illegible]. As is well known, the iron is [illegible] to have remarkable [illegible] properties, including a high permeability and small [illegible] and [illegible]. It is expected that [illegible] will largely replace the [illegible] of which the [illegible] had a monopoly before the war.

CORRESPONDENCE.

WILLIAM DUDDELL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: To the notice of William Du Bois Duddell in your issue of November 9th, may I be allowed to add a few words to illustrate his inherent mechanical instinct, from facts which I learnt from his family when attending his funeral last Thursday?

At the age of four he was given a model mouse as a toy, and not satisfied with its immobility, he took the works from a small clock and fitted them unaided into the interior of the mouse, turning it into a successful automobile. From that time forward his nursery became a fairyland of automatic toys, all made by himself, and mostly grouped so that several separate toys went through their movements at once, all worked from a central source of power. This inborn instinct for mechanical movements may well account for, though it does not explain, Duddell's wonderful aptitude in making simple apparatus to indicate or measure complex physical effects.

To those for whom the man and his spirit is of greater moment than the things which his imagination created it may be of interest to know that he never went to a big school. That until he was past the age of 20 his people never knew if he would live beyond the current year, and that after that he was always struggling against asthma. Had Duddell's body been gifted with health and strength at all comparable to his gifts of intellect there is no knowing what he might not have accomplished. He never had the chance of gaining the self-confidence which success in field sports gives to a boy, stimulating his ambition to succeed in the more serious matters of life, but no trained mountaineer was ever more determined to reach the summit he set out to reach, however long the journey or however stiff the climbing.

The success he attained in spite of his handicaps has been, and it is to be hoped will long remain, a stimulus to many of his less gifted friends and admirers. I am, &c.,

London, Nov. 12. ROGER T. SMITH.

PHYSICAL SOCIETY.

At a meeting held on the 26th ult., at the Imperial College of Science, Mr. W. R. COOPER, M.A., Vice-President, in the Chair, a Paper entitled

"On a Class of Multiple Thin Objectives,"

was read by Mr. T. SMITH, B.A.

The objectives dealt with are cemented combinations of several thin lenses. Two types of glass only are employed, the odd elements being of one kind, e.g., crown, and the even elements of the other kind, e.g., flint. Such lenses may be regarded as combinations of achromatic cemented doublets, and formulæ are found for the aberration coefficients of such lenses in terms of those of a standard doublet when the geometrical conditions for the absence of air gaps between the components are satisfied. Generally speaking, the results reached are that the outer surfaces are concerned with coma, and the internal surfaces with spherical aberration. In all cases the determination of a system to satisfy given conditions involves only the solution of a quadratic equation, and an algebraic method thus effects a solution in a fraction of the time involved in a trigonometrical investigation. Chromatic differences of first order aberrations are readily determined.

The application of the method is illustrated by a series of quadruple objectives which satisfy the ordinary conditions for telescope objectives. Diagrams show the variation of the curvatures with the different forms, the magnitude of the second order spherical aberration and the chromatic differences of first order aberrations.

Prof. A. W. PORTER congratulated the author on the increased simplicity given to the treatment of some of these important problems. He thought a good case had been made out for the further numerical investigation of this type of objective, and hoped the author would let the Society have the results of such an investigation soon.

[illegible] and that the Paper could not be regarded as of much practical value. No practical optician would think of constructing a telescope objective of four or more cemented components; even a triple objective is avoided whenever possible, as the technical difficulties are very serious when there are several cemented faces in a lens of considerable size; and he could not conceive of the necessity of such complication ever arising in small lenses for telescopes.

Mr. T. SMITH said a very great deal of work would be involved in a systematic exploration of the properties of multiple lenses over the possible range of optical glasses, and the publication of such an extension could not be expected in a short time. He did not quite understand Prof. Conrady's point of view, which would be most deplorable if it were generally adopted by the optical industry; for it could only lead to utter stagnation. Obviously there were always difficulties in making a complex rather than a simple instrument; but difficulties must not be allowed to retard progress, and no investigation should be starved out because of them. Unless investigations are made it is impossible to say whether the advantages they may show are sufficient to compensate the attendant disadvantages. As a matter of fact the question of employing quadruple objectives had actually arisen as a practical proposition in an instrument designed by a practical optician. In the particular case the optical conditions turned out to be unfavourable to the use of such a lens. Had it been otherwise there is no doubt it would have been employed, and any technical difficulties—which were not regarded as a deciding factor—would without doubt have been overcome. In Germany certainly, and in this country also, he believed, quadruple and even quintuple cemented objectives had been made.

A Paper, entitled

"The Radius of the Electron and the Nuclear Structure of Atoms,"

was read by Prof. J. W. NICHOLSON, M.A., D.Sc., F.R.S.

The electron is usually regarded as a globule of electricity with a definite radius. This conception has proved valuable, but involves difficulties in connection with the nuclear structure of complex atoms. On the view that the electron consists of a region of strain in the æther such line constants should have some significance throughout the whole æther; which may, in fact, be in some manner cellular with these linear magnitudes involved in the specification of the cells, and, therefore, in any strained structure composed of them.

The electron would be regarded as a state of strain which for practical purposes is concentrated at its centre, rapidly diminishing outwards according to some very convergent law involving some line constant in its specification. By way of illustration the idea is worked out mathematically on the assumption that the strain varies as $e^{-\lambda r}$, on which hypothesis λ^{-1} is the "radius." It can be shown that the Lorentz formula for mass as a function of velocity can be obtained for this type of electron. The charge on the electron is regarded as a fundamental property of the æther, and is related to Planck's constant h.

Dr. H. S. ALLEN: There can be little doubt of the existence of a relation, referred to by Prof. Nicholson, between Planck's constant h and the charge of an electron e. The relation suggested by Lewis and Adams may be written

$$ch = \sqrt[3]{\frac{8\pi^5}{15}}(4\pi e)^2,$$

where c is the velocity of light. Taking Millikan's latest value for e ($4\cdot774 \times 10^{-10}$) and $c = 3 \times 10^{10}$, we find $h = 6\cdot558 \times 10^{-27}$. From his photo-electric experiments Millikan found $h = 6\cdot57 \times 10^{-27}$ within about 0·5 per cent., and in his latest table of fundamental constants he gives $h = (6\cdot547 \pm 0\cdot013) \times 10^{-27}$. Thus the agreement is within the limits of experimental error. All the principal radiation constants can be expressed in terms of e. The curious numerical relations between the primary constants of physics, to which attention was directed in my Paper read before the Society in 1915, depend upon the above formula connecting h and e. On the lines suggested in Prof. Nicholson's Paper it would seem as if most, if not all, of the important constants of nature may be referred to some fundamental property of the æther.

Sir OLIVER LODGE (communicated): I am much interested in Prof. Nicholson's ingenious plan for doing away with the definite boundary of an electron, and devising a mathematical scheme which shall enable us to regard it as a point centre of strain decreasing exponentially in every direction without limit, so that the linear dimension associated with it shall be, like many time constants, the distance at which the density is reduced to 1/eth of what it is at the centre. This plan, if it can be developed properly, seems to get over many of the difficulties about the coherence of parts of a charge, and about the extraordinary properties of a nucleus, which though, from some points of view, an extremely small and highly charged unit, yet necessarily has a complexity which enables it to be disintegrated and fired off in fragments. The ready permeability or inter-penetrability without destruction, of Prof. Nicholson's conception of an electric unit, seems likely to diminish the difficulty of conceiving such a nucleus, and on the whole his suggestions seem to me helpful and valuable. I do not feel justified in saying more at the present time.

Prof. NICHOLSON, in reply, said it was of interest to see that Millikan's final value of h was practically equal to the first value that had been obtained for that constant.

THE RÖNTGEN SOCIETY.

The presidential address to the Röntgen Society was delivered on November 6th by Capt. G. W. C. Kaye, D.Sc., who took as his subject the various uses—chiefly, but not exclusively, medical—to which X-rays and electricity have been put during the war. One of the non-medical applications which he mentioned was the use of X-rays for the detection of contraband metals, the examination of autogenous welds, and the scrutinising of steel and other metal castings and plates for faults and blow-holes. Such work demanded high voltages and the heaviest outputs. Already steel plates over an inch in thickness had been successfully examined. At the conclusion of the address Mons. H. Pilon showed some lantern views illustrating the results obtained in the way of X-ray penetration through heavy metals. One of these results showed the faulty welding of a tank, having a 10 mm. thickness of wall, and another showed a faulty part in an aluminium gear case in which air-holes had been filled with aluminium alloy of a higher atomic weight; and in yet another the difference in the X-ray shadow made it possible to detect a piece of nickel in the middle of a piece of iron.

Capt. Kaye's position as a physicist, however, lent special interest to the part of his address which dealt with the physical aspect of radiology. He said that the outbreak of war found the X-ray manufacturers, like everybody else, quite unprepared. The X-ray bulb-maker was at once confronted with the absence of glass, which had previously been supplied from Germany. The problem of producing a uniformly good glass which would stand up, without puncturing, to the high voltages obtaining in practice was very difficult, but it was gradually being surmounted by State aid. It was remarkable how slight had been the changes in design experienced by the target tube, introduced in 1896 by Sir Herbert Jackson, but he would be a bold man who would assert that the present design had approached finality or anything like it. All X-ray tubes were, in fact, extraordinarily inefficient things. The heat they generated was proof of that. Under favourable conditions use was made of rather less than 1 part in 1,000 of the energy imparted to the cathode rays in the X-ray bulb.

As to the future of the X-ray tube, Capt. Kaye thought it possible that the radiologist would provide himself with a battery of tubes each with a different metal for the anti-cathode, and each labelled with (1) the appropriate voltage for exciting the useful characteristic radiation of the anti-cathode in question, so as to get the homogeneous rays which the medical man wanted; and (2) the appropriate absorbing screen, with its nature and thickness. In radiography, for example, the radiation of the heaviest metals, such as tungsten, platinum and uranium were sufficiently hard for the purpose, and the voltages required ranged from about 80,000 to 160,000 volts, according to the metal chosen. If softer rays were required for therapeutic or other purposes, an anti-cathode of lower atomic weight would be used, care being taken to see that its physical properties made it suitable for the purpose, and the right voltages would be applied to generate the characteristic radiation and remove the softer rays by absorption. If harder rays were wanted the procedure would be, not to increase the voltage, as that would chiefly strengthen the general spectrum of rays, but simply to choose another tube of greater atomic weight. He thought the plan was worth trying. He had not yet had an opportunity of doing so, but he knew that it was very successful with metals of medium atomic weight excited by appropriate voltages. In [illegible] he had managed to obtain 90 per cent. homogeneity, though he could not think the degree of [illegible] would be met with in the case of the heavier atoms.

THE RELATIVE MERITS OF STEAM-DRIVEN AND ELECTRICALLY-DRIVEN STATION AUXILIARIES.*

BY [illegible]

[illegible]

in the case of a good number of these there is no choice as to the method of driving. On account of position and size of many of them, the only sensible arrangement is to drive them electrically.

A special case, however, is presented in the condenser auxiliaries, and in a lesser degree the feed pumps. As far as possible this auxiliary plant should operate independently so as not to be affected by large or small incidental troubles which crop up in the running of a station or distribution system. It is disastrous if on every fault of the system these auxiliaries are affected, or fail altogether on larger troubles; causing delay in resumption of supply. If no objections existed these considerations would at once lead to the adoption of separately driven auxiliary plant, but, as is usually the case, certain drawbacks may exist and the two systems still have their advocates.

First, condenser auxiliaries. These auxiliaries comprise the circulating water and air pumps, both of which are adapted to electric driving. In modern plants of any size both are usually centrifugal pumps. In a well designed electrically-driven plant, maintenance costs are light and the running costs according to partisans of the system are lighter than is the case with steam-driven pumps; this statement, however, remains to be proved.

Taking, first the cost of electrically-driven pumps. Suppose the power required to be 200 H.P. or 150 kw., the motor efficiency will be about 85 per cent., and hence the demand at the transformer will be about 177 kw. Assuming the transformer efficiency to be 97 per cent., the demand at the station bus bars will be 183 kw. approximately.

Next take the case of steam-driven pumps. The usual practice in this case is to put a small turbine in a sort of shunt circuit, exhausting to some convenient point in the main turbine where the pressure is sufficiently reduced. We will suppose the steam consumption of the main set to be 15 lb. per k.w. hr. It may be assumed that the auxiliary turbine is not more than 20 per cent. less efficient than the part of the main turbine which is short-circuited by the auxiliary steam, and hence the steam necessary to give 150 kw. at the auxiliary turbine would, if passed through the main turbine, have produced at the generator 180 kw., and hence by comparison the steam-driven set is quite as efficient as the electrically-driven one. If the assumption made regarding efficiency is correct, there is no advantage on the score of running costs in electrically-driven sets. We might therefore compare the two systems as follows. In reliability, the steam-driven set has the advantage. In running costs, there is not sufficient difference to lend weight to choice. Maintenance costs are probably higher in steam-driven than in electrically-driven auxiliaries. This latter point, however, is largely a question of design, and there is little doubt that the near future will produce a plant which will be quite comparable in this respect.

Now let us consider feed pumps. The difference in opinion as to the method of driving this part of the plant is not so marked. [illegible] question that the over all efficiency of the small turbine exhausting [illegible]

[illegible]

* [illegible]

LEGAL INTELLIGENCE.

Postmaster-General v. Blackpool & Fleetwood Tramroad Co.

At Blackpool County Court last week the Postmaster-General claimed £16. 1s. 8d. from the Blackpool & Fleetwood Tramroad Co.

Mr. Ross Brown said though the action was brought for the recovery of a small sum the importance arose from the question of liability which both parties desired to be settled. The amount of the claim was for the cost of making good damage to the telegraph and telephone cables alleged to have been caused by leakage from the tramroad. The claim was brought under a section of the Act obtained by defendants, and alternately under the Telegraph Act of 1878. The current was generated at Bispham, and the Post Office cable ran almost parallel to the tramroad, but owing to imperfect bonding of the tramroad there was a leakage of current which pitted the lead sheath, and in the course of time the cable was destroyed by electrolysis, and had to be replaced at the cost of the claimant. Counsel said he understood that the case for defendants was that as the tramroad was there before the Post Office cable was laid they were not liable.

After evidence had been given as to the escape of electricity and the damage done, Mr. Wingate Saul (for defendants) said that the tramroad company was constituted as a railway company, and unless they were guilty of negligence they were not liable. If they were carrying on the tramway in a proper manner, and in accordance with the Board of Trade regulations, they were not liable for any damage which might happen from an escape of electricity. The section in the company's Act regarding telegraph and telephone lines referred to the lines in existence when the tramroad was made, and not to any lines which might ultimately be put down. He urged that the company had not done anything to damage the cable, because it was laid after the tramroad was constructed.

His Honour reserved judgment.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1916 Specifications.

5,237 [illegible]. Automatically controlled electric water and other heaters (19/10/16.) 109,979.

[illegible] [illegible] and heating of railway or other vehicles. [illegible] (Addition to 19,977/14.) 109,985.

12,986 Pupin & Armstrong. Electrical wave transmission. (17/9/15.) 101,541.
A receiving conductor for electromagnetic waves, in which the resistance introduced therein to screen the system against disturbing electromagnetic waves is [illegible] capacity and serving to transfer power selectively to the conductor to produce a resistance neutralising reaction therein and compensate to any desirable limit the losses due to the dissipative resistance introduced into the receiving conductor.

12,987 Pupin & Armstrong. Wireless systems and the like. (1/10/15.) 101,702.
Relates to a receiving conductor for wireless wave transmission, having a high resistance load uniformly distributed along the same so as to diminish the effect of waves of all lengths and frequencies met with in wave transmission.

12,988 Pupin & Armstrong. Transmission of electrical signals. (10/2/16.) 104,158.
Relates to a receiving conductor in energy-transferring relation to the energising [illegible] interval of energy transmission over the wave conductor, whereby the positive [illegible] duration.

13,707 Crawford & Preston. Electric switches. (27/9/16.) 109,992.

[illegible]

[illegible] (7/12/16.) 110,057.

[illegible]

APPLICATIONS FOR PATENTS.

[illegible]

October 13, 1917.

14,838 Kynochs & Kievits. Electric furnaces of the heated coil type.
14,839 Dunlop. Portable battery lamps.
14,865 Head. Production of metallic tungsten powder direct from sodium, potassium ammonium, calcium and magnesium tungstates.

October 15, 1917.

14,884 Chapman. Magnetophones and a.c. electric generators with oscillating fields.
14,893 Steel & Watson. Portable electric grinder.
14,899 Lamkin. Sparking plugs.
14,908 Mengo-Elma Synd. & Pollard. Electromagnetic friction clutches for motor vehicles.
14,915 Bertoya. Manufacture of tungsten metal power.
14,918 Bonnella. Electric lamp fittings.
14,932 & 14,933 Dixon. Electrically-heated steel furnaces. (14/10/16. U.S.)
14,936 Teed. Electric switches, &c.

October 16, 1917.

14,969 Paul. Magnetically-operated contact makers, &c.
14,976 Owen-King & Pearce. Controlling X-ray tubes.
14,979 Morrison. Wood separator for battery plates.
14,981 Kesselring. Continuous-current dynamos.
14,991 Joel. Electric accumulators.
14,992 Callender's Cable & Construction Co. & Worsdell. Troughs for cables, &c.
14,999 Merz & McLellan & Bisacre. Protective devices for electric cables.

October 17, 1917.

15,010 Barrows. Sparking plugs.
15,040 McLean. Electric adapters, &c.
15,069 Clarke. Sparking plugs.
15,076 Adams, Ablitt & Quincey. Grids for storage batteries.

October 18, 1917.

15,097 Romanes. Electric furnaces for smelting and refining steel.
15,111 Donovan. Fuse boxes and switches.
15,127 Stevenson. Armour cable-bonding gland.

October 19, 1917.

15,172 Clifford. Electric lamp.
15,176 Sarkar. Insulations for h.t. elec. instrument transformers, &c.
15,204 Western Electric Co. Polenkowsky & McBerty. Machine switching telephone system.
15,205 Edwards & Lucas. Electric connections.
15,210 Caretta. Electrically-heated soldering iron.
15,213 Varty. Sparking plugs.
15,214 Hellyar. Electric lamps.
15,219 Milne. Electrical fittings.
15,228 Soc. Automateime et Appareillage & Engelhard. Electric time relays.

October 20, 1917.

15,264 Dobell. Subaqueous searchlights.
15,272 Holophane (Ltd.). Glassware for illuminating purposes.

October 22, 1917.

15,302 Brothers. Electric switches for lighting and ignition for aeroplanes, &c.
15,304 Hills. Electric flash-lamp walking-stick, &c.
15,314 Buley & Treherne. Electric hand lamps.
15,316 B. T.-H. Co. (G. E. Co.) Induction motors.
15,330 Clark & May. Galvanometers.
15,348 Atkinson. Insulation of electric conductors.

October 23, 1917.

15,369 Bailey. Electric trams, &c., propelled by overhead wire.
15,383 Coplan. Adjustable electric fittings of pendant type.
15,393 Fletcher. Ovens, &c., heated by electricity, &c.
15,394 B. T.-H. Co. (G.E. Co.) Electrical transmision.
15,404 Kent & Pullman. Electric clocks.
15,415 Geary. Electric controllers for direct-current motors.
15,419 Kartret Engineering Co., Middleton & Baker. Electrical switches, links, &c.
15,425 Casella. Machines for making electrodes. (7/12/16. U.S.)
15,402 & 15,403 Newman. Removing tubes deposited by electrolysis upon mandrels.

October 24, 1917.

15,431 Harris. Means for cooling electric motors.
15,445 Walster. Generating coal gas in electrically heated retorts.
15,451 Nalder Bros. & Thompson. Speed indicators.
15,464 Watt. Aerial circuits for wireless telegraphy.
15,498 Soc. Française Radio-Electrique. Radio telegraphy or telephony. (24/10/16, France.)

October 25, 1917.

15,505 Jones. Electric muffles.
15,514 Potts. Electrical make and break contact.
15,541 Cotte. Electrical accumulators. (25/10/16, France.)
15,543 Latour. Audion or lamp relays or amplifiers for wireless telegraphy and telephony. (23/10/16, France.)

October 26, 1917.

15,583 Engelke. Automatic arc lamps.
15,610 & 15,611 Lyon & Rogers. Wireless signalling. (10/11/16, U.S.)
15,612 Enclosed Motor Co., Jacoby & Mossay. Dynamo-electric machines.
15,629 Soc. de Metallurgie Electrolytique. Electrolytic production of zinc, copper, &c. (28/10/16, France.)
15,635 Papa. Electric light apparatus.

VOLUNTEER NOTICES.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Oxford-street, W. 1.

Orders for the Week.

Officer Commanding, Lieut.-Colonel C. B. Clay, V.D.

Officer for the Week. Lieut. C. E. Campbell.

Next for Duty. Lieut. W. J. A. Watkins.

Drills: Week ending Sunday, Nov. 25, 1917.

Monday. No. 3 Company, Left Half, Recruits, Signalling, 6.30.
Tuesday. Physical Drill and Bayonet Exercise, 7.30.
Wednesday. No. 1 Company, 6.30.
Thursday. No. 2 Company, 6.0. Signalling, Ambulance, 6.30.
Friday. No. 3 Company, Right Half, Recruits, 6.30.
Sunday. Commandant's Parade for heavy bridging instruction at [illegible] Parade Waterloo Station, opposite No. 10 platform, 8.35 a.m. Uniform, Haversack and waterbottle. Midday rations to be carried. Compulsory for men in sections A, B and C.
Musketry. Belvedere-road, Tuesday, Wednesday and Thursday, 5.30 to [illegible]

Note.—The Medical Officer will attend for examination of recruits, &c., on Thursday at 6.0.

All enamelled cap badges must be returned to the Quartermaster-Sergeant without delay.

Unless otherwise indicated, all drills will take place at headquarters.

COMMERCIAL & INDUSTRIAL SECTION.

Reconstruction After the War.

In the course of his presidential address before the Institute of Bankers last week, Sir Richard V. [illegible] Smith referred to recent banking developments and to the problems of reconstruction after the war.

Sir RICHARD said that we should have to shoulder a heavy financial burden, but it would depend entirely on the way we set about our task if this burden was to cripple our efforts. The work of reconstruction would be long and arduous. One thing was certain: we should not go back to the conditions which existed before the war. He hoped we would face the work of re-building not in the spirit of mutual hostility, suspicion and distrust, which was before the war so lamentably evident. We must remove as far as possible all friction from the machinery of progress, and it was one of the first requisites of success that we all approached the problem in a spirit of goodwill. In addition to a huge debt there would be the cost of repairing the wastage caused by the war, and money must be found for enlarged works and machinery to provide the means for increased industrial production. Only by greater industry and production could we meet our difficulties. The first and most serious question was the relation of capital and labour. British trade was capable of vast expansion, and he believed that by that expansion means might be found for a better remuneration of labour sufficient to provide a higher standard of living, with shorter hours of work and better housing, and, in addition, a share of the profit, after providing a proper return upon the capital employed, with reserves for depreciation and betterment. We must disabuse our minds of the old fallacy that low-paid labour is necessarily economical, and that a high rate of wages is a handicap to a nation in competition for the markets of the world. More than one country—the United States of America in particular—has had to face this question of high-paid labour and has faced it successfully. But to do this it will be necessary to economise labour, and in this task we should have the loyal co-operation of the working man. Reasonable holidays should also be allowed, with pay. Why should the conditions of manual service be different from clerical service? Why, when works must be closed for a periodical overhaulage of machinery, should the men be compelled to give up their occupation without recompense? As for the serious question of demobilisation, there ought to be no fear of unemployment if we were all of one mind with regard to the increased output. Production, however, without markets would not be sufficient; and, while it was to be hoped that we [illegible] be in a better position to supply our home demands, we should have to seek wider fields in the Empire and in foreign countries. Men would be required to go abroad, and a knowledge of foreign languages and [illegible] must be a necessary qualification. One of the outstanding features of our productive industries during the war had been their [illegible] on a large scale and their control by the State. Both organisation and control had been [illegible] forced upon us by the war. As regards State control, he believed that the necessity [illegible] temporary, but he firmly believed that the necessity for organisation would remain with us after the war. The day of small [illegible] was gone. Our manufacturers and traders must [illegible] and the question of financing our industries [illegible] organisation.

* * * *

Excess Profits and After-War Trade.

In an interesting communication to *The Times* of the 12th inst., Sir Algernon Firth discusses the [illegible] of excess profits duty.

Sir Algernon, who is President of the Association of Chambers of Commerce, states that [illegible] the interests of the country. [illegible] It would be [illegible]

Objection to Bonus System.

In the United States of America [illegible] in the boiler house have been [illegible] by several companies. [illegible] objection is raised to the system on account of the fact that it leads to fraud and dishonesty.

For instance, Mr. E. H. Perry, assistant chief engineer of power plants in Chicago, thinks "it is fundamentally wrong to employ the system, for it cannot help but induce the men in the plant to resort to dishonest practices in order to earn the bonus." In one instance which came to his notice a locomotive engineer reported a run of several thousand miles on a quart of cylinder oil, when in fact he had been oiling his engine with lard oil stolen from lanterns. In another case where a bonus was paid on waste, in order to reduce needless consumption thereof, one man was found to have his locker full of waste which he had accumulated at the expense of his fellow workers. In another case coal scales were ingeniously tampered with in order to make the coal consumption low enough to earn the bonus. Mr. Perry believes that the better plan is to provide the boiler-room force with the best devices for convenient operation and accurate checking of results, and then to hold the force responsible for getting the best results. Accordingly his power plant has been equipped with automatic coal-weighing scales, flow meters, automatic feed-water regulators and other devices. Conditions have been worked out so well that now one man takes entire care of 10 boilers.

* * * *

Talc Discovery in South Africa.

The discovery of a rich talc deposit near Barberton, South Africa, will probably mean the development of a new and important industry for the Union. Hitherto, says the [illegible] Organisation, the United States have led the world both in the production and use of talc and soapstone, other producing countries including Austria, Italy, and France.

The Barberton deposit [illegible] highest quality. Talc has a large variety of industrial uses, notably for tips for gas burners [illegible] articles of domestic use. When ground, it is used as a filter for paper, for covering steam-pipes, as a lubricant for dressing skins and leather, and for other purposes.

* * * *

Germany's Foreign Trade.

According to the issue of "Der Weltmarkt" [illegible] the secretary of the German [illegible] published particulars of [illegible] Central [illegible] for Foreign trade in Germany, [illegible] associations connected with foreign trade.

The various departments would be arranged geogra[illegible] to the countries to which the export is directed, [illegible] central office to deal with tariffs, transport, law [illegible] of Austria-Hungary.

* * * *

Norwegian Business Interests in Russia.

It is reported that [illegible] Norway [illegible] after the war. [illegible]

ELECTRICITY SUPPLY.

EXTENSIONS.

Glasgow.—It is proposed to lay a high-tension cable from the new electricity works at Dalmarnock to St. Andrew's Cross works.

Maidstone.—The L. G. Board have sanctioned a loan of £2,106 for laying a new main to premises at Messrs. Tilling-Stevens (Ltd.).

Sheffield.—A feeder cable is to be laid between Neepsend and Jobson-road sub-station at a cost of £4,585.

To meet the recent advance in the cost of coal all accounts for the supply of electricity now charged at 2d. per unit and under, are to be subject to an increase of 25 per cent. in lieu of the 20 per cent. hitherto charged.

The Parliamentary Committee recommend the Council to confine their application for a provisional order to supply electricity to the following districts, viz.: The Urban Districts of Handsworth and Dronfield, the Rural Districts of Wortley and Norton, and the Parishes of Coal Aston and Dronfield Woodhouse.

The City Council have granted the following increases in salaries: A. R. Fearnley, general manager, tramways and motor department, present salary of £1,000 a year, to be raised by two annual increments of £100 each; that the maximum salaries of shift engineers in the electric supply department be increased to £220 per annum, and that the salaries of the following shift engineers be raised by £20 per annum in each case: Messrs. H. Price, W. H. Smith and Mr. T. Roberts.

West Hartlepool.—The Corporation have conditionally agreed to give an additional supply of electric power to Messrs. Batchelor, Robinson & Co. The cost of the necessary cable and switchgear is estimated at about £2,000, and application has been made for sanction to borrow this sum.

Woolwich.—On Tuesday the London County Council sanctioned a loan not exceeding £4,184 to the Borough Council for a motor transformer and other electrical plant. The period of the loan is 15 years.

GENERAL.

Arbroath.—The Arbroath Electric Light & Power Co. has intimated that, owing to the great increase in cost of production, and especially in the price of coal, it has been found necessary to put in operation the minimum charge of £2 per annum for lighting, as authorised by the Arbroath Electric Lighting Order.

Belfast.—In reporting to the Council last week, the Tramway and Electricity Committee stated that they had passed a vote of thanks to the electrical staff for services during periods of danger.

During the two strikes in May and in August, through the loyalty of the staff the public had suffered no inconvenience. Referring to the revenue and expenditure for the half year ended Sept. 30 last, [illegible] that the total revenue for the six months was £106,571, against [illegible] for the corresponding period. The expenditure reached [illegible] £107,070, against £89,723 and the gross profit was [illegible] £22,248. Net revenue and appropriation charges came to [illegible], reducing the gross profit to £316, against £3,883 for the first six months of 1916. Of the increased expenditure traffic expenses represented [illegible]; repairs and maintenance, £3,573; power, £4,542; and general expenses [illegible]. Had it not been for the additional revenue brought in by the [illegible] there would have been a deficit up to the end of [illegible] £17,000. There was no available balance [illegible] the deficit on last year's trading of nearly £7,000 [illegible] existing circumstances it would be [illegible] substantial surplus to be earned during [illegible] additional burden on the undertaking would [illegible] position.

Bettws-y-Coed.—The supply of electric current was cut off [illegible] getting into a water pipe and [illegible] Current is generated by hydro-electric [illegible].

Birmingham.—*Common Good Fund.*—In referring [illegible] the Lord Mayor, Ald. [illegible] stated at the [illegible] that he had received a letter [illegible]

[illegible]

given. The sums already paid over for the endowment fund amounted to £10,000, and the value of the investments already handed over as a start of the amenities fund were £3,000.

The Lord Mayor, in moving that the thanks of the Council be accorded Mr. G. Cadbury, jun., for having founded the trust and the anonymous donors, said the Corporation in the past had frequently missed opportunities of securing land of great value to the community because they could not define the precise statutory purposes for which it was intended to be used, and often had had to pay an extra price because of the necessity of first obtaining the consent of the Council and so making their intentions public. They had some knowledge of the value of a Common Good Fund to Glasgow and other cities, and had long felt the need of a trust of that description in Birmingham.

The resolution was carried.

Burley-in-Wharfedale.—As the Electrical Distribution of Yorkshire (Ltd.) will not agree to insert a purchase clause in their proposed provisional order the Council have withdrawn consent to the company's proposed scheme of electricity supply.

Clayton.—Before deciding to support the proposed application of the Electrical Distribution of Yorkshire the Urban Council has decided to obtain terms from Bradford Corporation for the supply of electricity in the district.

Edinburgh.—At the meeting of the Corporation on Friday the Electric Lighting Committee reported that the increase in the price of coal of 2s. 6d. a ton would mean an increased cost to the electric supply undertaking of about £4,700 up to May 15, 1918.

The year's estimates showed a credit balance of about £1,600. Utilising this with the present rates for electricity, there would be a loss of about £2,400 at the end of the year. It was estimated that an increase of ½d. per unit on lighting from Oct. 1 would give an estimated credit balance of £500, and the committee recommended that the rate for lighting be increased. The rate for lighting was increased by ½d. as from May 15 last, and the present increase would bring up the rate for lighting to 3⅝d. per unit.

The recommendation was unanimously adopted.

Electric Power Supply Committee.—Referring to our note last week on the quarterly meeting of the Executive Council of the Urban District Councils Association, we now learn from the report of the Sub-Committee that the name of Mr. A. H. Dykes (of Messrs. Handcock, Dykes & Trotter) was suggested by two Councils as a witness on behalf of the Urban District Councils owning electricity stations. Mr. Dykes was accordingly invited to appear as an engineering witness for the Association, and his evidence was taken by the Committee on Oct. 1. The Committee expressed their indebtedness to Mr. Dykes for the care and attention which he gave to the matter, which involved a great deal of work and must have occupied a considerable amount of time.

Increased Charges for Electrical Energy.—The charges for current are being increased at the following places:—

Kingston (Surrey) Council has decided to add 1½d. per unit to the charge for current for power, in lieu of the increase of 20 per cent. on the scale.

Walsall has increased the temporary advance of 20 per cent. in the charges for electrical energy to 40 per cent. In the case of certain bulk supplies the increase is to be 0·02d. per unit for an increase of 1s. per ton (instead of 1s. per ton, as formerly) in the cost of coal.

Nottingham Electricity proposes to increase its charges by 7½ per cent.

Derby Corporation is increasing its charges for current for lighting and power by 10 per cent., as from Dec. 1.

Sheffield Electric Supply Committee has decided to increase the charges for all current now charged at 2d. or less per unit by 25 per cent., in lieu of the present 20 per cent.

[illegible] Corporation is increasing its charges for current for lighting, heating and small power consumers from 12½ to 25 per cent. over pre-war prices.

York Electricity and Tramways Committee propose to add 10 per cent. from Jan. 1 to the charges for current to all private consumers and power users.

Kingston (Surrey).—At the meeting of the Council last week the [illegible] Committee reported that they had received an offer from [illegible] Electricity Corporation (Ltd.) to take over the Corporation's electricity works.

The Council adopted the Committee's recommendation that the offer [illegible] the company be informed that if they are prepared [illegible] satisfactory offer the Corporation will give it careful [illegible].

Northampton.—On Friday the [illegible] Council were asked to pass the following [illegible] which was moved by Mr. A. E. Allen: [illegible] now being prepared by the [illegible] the coal resources of the country [illegible] from a limited [illegible] that the natural advantages [illegible] should be placed before the Govern-

ment with a view to the establishment of one of the proposed great stations in this district. That a committee of the Council be formed to investigate and consider and report on the details of the proposed national scheme.

Sheffield Development Scheme.—Some time ago the Development Committee advertised for an executive officer for the new development department.

Over 40 applications were received. [illegible] applicants were unsuitable for the [illegible] [illegible] not had special experience in relation to [illegible] which the committee considered most desirable, if not essential. In [illegible] with in connection with and as part of the town clerk's department, and that it be carried on under the direction of the deputy town clerk.

[illegible] principal officials of the Corporation, particularly the general managers of the [illegible] and [illegible] supply departments, [illegible]

Sheffield. Last Wednesday the Council decided to apply [illegible] to enable them to [illegible] in the Chesterfield Rural area, Norton and Wortley.

At last week's meeting of the Corporation, the new Lord Mayor (Ald. A. Cottell), in accepting office, referred to the part played by Sheffield in the war. After referring to schemes for town planning and street improvement, he spoke of the effect of the war upon the electric supply department. He said it was clearly the duty of the Corporation to ensure that the undertaking should be put in a position to supply adequately and cheaply sufficient power to enable Sheffield industries to successfully compete in the world's market for the enormous trade developments at the end of the war. He hoped to see the first portion of the Blackburn Meadows works completed during his year of office.

Sheffield and Rotherham Linking-up. A conference was recently held between representatives of Sheffield and Rotherham on the question of the linking up of the electric power stations of the two Corporations.

The conference decided to recommend to each of their authorities the desirability of linking up the two undertakings, and instructed the respective engineers to meet and endeavour to agree to a tentative scheme to carry this into effect, such scheme when arranged to be submitted to the respective Electricity Committees for consideration.

Sheffield Trade. The "Sheffield Daily Telegraph" reports that the [illegible] supply of electrodes [illegible] for the [illegible] of the erection of [illegible] furnaces without a special [illegible]

[illegible] A new factory [illegible] erected in Norway for the manufacture of carbon and graphite electrodes, the output of which will be about [illegible],000 electrodes per annum [illegible] are sufficient to ensure profitable working. The works will be in operation before the end of the year.

[illegible] appearing gradually from the [illegible] seded by a compact, neat and [illegible] cheaper than ordinary hardening meth[illegible]

Westminster. [illegible]

ELECTRIC TRACTION.

Belfast Tramwaymen's Wages. [illegible]

Birmingham. [illegible]

Keeping Places Open.—"The Times" of Saturday contained some correspondence which has passed between Sergt. W. M. Ronaldson, former traffic superintendent of the Falkirk and District [illegible] Hays).

The substance of the correspondence is that the directors, owing to the unexpected length of the war, cannot keep Mr. Ronaldson's position open any longer, and that a permanent appointment will require to be made.

L.C.C. Tramways.—At Tuesday's meeting of the London County Council the Highways Committee [illegible] alterations made in the issue of transfer tickets to passengers, and stated:

"The experience of the management confirms our expectations that the alteration in transfer facilities would lead to more effective control over the traffic; and it is satisfactory to note that the alteration is having the effect of improving the carrying capacity of the tramways by acceleration of the services. It was to be anticipated that any change not obviously for the benefit of passengers would lead to criticism and, perhaps, to complaints. We are glad to find that the volume of [illegible]

Mr. H. H. [illegible]

Mr. J. D. Gilbert [illegible] tency in the transfer arrangements for South London.

Mr. Hayes [illegible] ment had failed.

Mr. [illegible] the service they were driven to make regulations restricting the facilities which they had extended in normal times. He asked members not to take action that would increase the difficulties of a harassed management.

The motion for [illegible] report was approved.

Tramway Control.—Replying to questions, Mr. R. C. Norman, chairman of the General Purposes Committee, said that the communication from the Board of Trade relative to the future control of the tramways of the country had been considered by his Committee, who had decided to ask the views of the Highways Committee upon the matter before replying. He was not prepared to say at the moment whether the Committee would refuse to be a party to any arrangement that did not also deal with the control of the motor-omnibus traffic in London as well as the electric tramways.

London United Tramways. [illegible]

Maidstone. [illegible]

Manchester. [illegible]

Sheffield. [illegible]

Walsall. [illegible]

TELEGRAPHY AND TELEPHONY.

Automatic Telephony in Australia. [illegible]

Wireless Telegraphy in Scandinavia. [illegible]

IMPERIAL NOTES.

Australasia.—The Brisbane City Electric Light Co. has secured an Order in Council authorising them to supply electrical energy within the extended area of the city of Brisbane.

The Mayor of Prahran (Victoria) is taking steps to bring about a consultation between the Tramway Board and the Melborne Tramway Co. in the hope of coming to an amicable settlement of the dispute as to the amount to be paid to the company as compensation for certain properties. Permission has been given by the State Court to both parties to appeal to the Privy Council against decisions given by the Court, and the object of the consultation will be to avoid the great expense involved in the appeal.

Williamstown (Victoria) Council's electric light scheme was completed within the estimated cost of £18,000, and public and private lighting was formally inaugurated in August.

The New South Wales Public Works Department, while willing to deviate the electric cable line from their power-house at Port Kembla to the Cordeaux dam work, through the main street of Wollongong, have refused to install the sub-station plant, distributors, &c. The Municipal Council considered the feasibility of doing the work themselves, but found that the difficulty of procuring electrical material was so great that another appeal to the department to carry out the work has been made.

Mr. Justice Higgins recently commenced the hearing of the claim of the Australian Tramway Employees' Association in the Commonwealth Arbitration Court (Melbourne), the respondents including the Prahran and Malvern Tramways Trust, the Hawthorn Tramways Trust, the Melbourne, Brunswick and Coburg Tramways Trust, the Hobart Council and the Kalgoorlie Electric Tramways (Ltd.). The association claimed increases of wages, so that the new scale would vary from 11s. up to 17s. (for engine drivers) per day. The wage proposed for motormen and conductors was 12s. 6d. per day.

The respondents denied that there was, properly speaking, a dispute extending beyond one State, and Mr. Justice Higgins announced that before he could make an award it would be necessary to get a finding of the High Court whether a dispute existed, and accordingly he referred the matter to the High Court.

In regard to the water survey for the purpose of hydro-electric development in Tasmania, Mr. J. H. Butters, chief engineer and general manager of the Tasmanian Government's hydro-electric department, states that a close watch is being kept on the probable demands for large blocks of electricity, in the near future and after the war. A commencement had been made in the production of a complete water survey of the whole state, and satisfactory progress had been made. Water-power development schemes must be based upon the driest years, and failure would be the result of any other procedure. It was not of the slightest use having an enormous rainfall or establishing the fact that an enormous flow existed, unless it could also be established that certain natural topographical features existed, which would enable that water to be economically turned into power. The economical side of the proposition had to be considered, and unless the fall could be obtained with a certain definite expenditure per horse-power, the proposition was useless. Certain streams and lakes had been ear-marked as suitable catchment areas for the development of water-power. Surveys had been conducted into the Upper Ouse, Arthur's Lake, Lake St. Clair, Lake Echo, the River Dee, the River Derwent, the Franklin River, the King River, &c. The Derwent River and Arthur's Lake had already demonstrated satisfactory water-power propositions. The Arthur's Lake scheme had also been further advanced by a survey of a canal to carry water from the Great Lake into Arthur's Lake by engineering surveys around Arthur's Lake and the survey of a number of possible pipe lines. That scheme would have a fall of over 2,000 ft., against 1,000 ft. in the Great Lake scheme. The Derwent River development was being tried out, and [illegible] pipe lines and canal routes had been surveyed, with a view to [illegible] the best. Certain areas were not likely to be able to support [illegible] schemes by themselves, whereas if undertaken in conjunction with the power scheme it might alter the whole aspect.

In a recent letter to the [illegible] Mr. R. L. Butler, secretary to the [illegible] of British Manufacturers and their Representatives [illegible] British trade interests by the [illegible] Department. [illegible] Mr. Butler [illegible] that Australia [illegible] British trade with Australia, and that [illegible] Australia [illegible]

Canadian Mica.—It is reported that the past year's production and shipment of mica from the province of Quebec amounted to [illegible] an increase of over 200 per cent. on the previous year.

[illegible]

MISCELLANEOUS.

Control of Metals.—It is reported that a French company has been formed, entitled the Société Minerais et Metaux, with a capital of 10 000 000 francs (£400,000), for the purpose of fostering and protecting the metal industries of France.

The company, which is thoroughly representative of existing interests, will seek to improve and extend the methods of distribution, treatment and marketing of the metals produced in France and her colonies, and will also provide financial facilities for their development. It will not be a profit-making enterprise so much as an organisation for securing the economic development of the country's mineral and metal industries.

Fire at Braunton Electricity Works.—A fire broke out at the electricity works of the Braunton Electric Light & Power Co. on the 5th inst., which did considerable damage, entailing the suspension of the supply of current.

On the 11th inst. we were informed that the supply had not been and could not be resumed until the plant had been restored. The exact extent of the damage has not yet been ascertained.

German Academic Honours.—In a "Note on Membership of German Academics and Scientific Societies," circulated among the Fellows of the Royal Society, it is pointed out that:—

No German scientific academy or society has not, so far as the signatories to the note are aware, issued any protest against the many infringements of humanity and of international law which have been characteristic of the German conduct of the war. Members of the Royal Society reprobate the action of the German Government in bringing on the war and its method of conducting it and it seems, therefore, incongruous that Fellows of the Society should continue to announce their membership of German academies and scientific bodies as an honour which they value. The eight signatories to the note, who include Sir James Dewar and Sir W. H. Perkin, state that they believe that there is a widespread desire for common action, and it is for this purpose that they have called attention to the matter.

King George's Fund for Sailors.—At the meeting of the General Council of this fund last week the Duke of Connaught, who presided, expressed his gratification at the progress of the Fund and hoped that the public would continue to support it generously.

The fund was of great advantage to the marine benevolent institutions and to the gallant men of the sea as well as their widows and children. To mark a sense of the importance of the fund the benefits it would confer on those to whom we were so much indebted, the King had contributed £5,000 towards the Fund, while the Duke himself had subscribed £500.

The deputy chairman (Capt. A. W. Clarke) announced that the fund had now reached £210,000, and stated that the expenses in connection with the raising of that amount were only $\frac{1}{2}$ per cent. The chairman of the Finance Committee (Sir Raymond Beck) then presented a financial report, which was unanimously adopted.

New York's Electric Signs.—It is announced that, except between 7.45 and 11 p.m. the electric display lighting of New York, including the huge advertisements on Broadway, are to be suppressed. It is estimated this will effect a saving of 125,000 tons of coal annually.

Parcels for Neutral Countries.—It is announced that on and after Dec. 17 nothing may be sent to any neutral country in Europe by sample post or (unless addressed to a prisoner of war) by parcel post by any person who has not previously obtained a permit from the Chief Postal Censor, 9D, Strand House, Carey-street, W.C. 2.

Patent Law Reform.—On Saturday Mr. V. A. B. Hughes addressed the members of the Manchester Association of Engineers on the British and foreign systems for the protection of inventions.

Mr. Hughes dwelt upon the advantages to the commercial community which would be gained by uniformity in the broad principles governing the patent laws adopted by various countries, including our own, and suggested methods by which the administration of these laws might be expedited, improved and cheapened. Mr. Hughes said engineers had been content to have the laws under which they worked, such as their patent and commercial laws, framed for them by politicians and others not vitally interested in the subject. Such an attitude was wholly indefensible, and under the stimulus of increased competition it was fast disappearing.

Trading With the Enemy.—The "London Gazette" of the 9th inst. contains additions to the list of persons and firms with whom persons and firms in the United Kingdom are prohibited from trading.

These include:—*Spain*: Centro de Instalaciones Electricas (Calle [illegible]), Madrid.

War Relief Fund.—The India Rubber, Gutta Percha & Telegraph Works Co. employees' war relief fund now amounts to £1,800.

Of each £100 collected £75 is sent to the British Red Cross Society, £15 to the [illegible] Relief Fund and £10 to the Anglo-Russian Hospital, Petrograd. There are now 1,020 members of the India Rubber Co.'s employees' weekly [illegible] association.

TENDERS INVITED AND ACCEPTED.

Telegraph and Telephone Instruments, Battery Material, Switchboards, &c.

Tenders are invited up to Dec. 5 and 12, 1917, respectively, for the supply to the Postmaster-General's Department, State of WESTERN AUSTRALIA, of telegraph and telephone instruments and battery material (to schedule W.A. 583) and telephone switchboards (to schedule W.A. 582). Tender forms, specifications, &c., from the office of the High Commissioner for Australia, Australia House, Strand, W.C. 2. *See advertisement.*

Railway and Tramway Stores.

BRADFORD Tramways Committee require tenders by Nov. 24 for 12 months' supply of stores, including controller fingers, contacts, &c., ironmongery, bolts, nuts and screws, insulating material and tapes, iron and steel, pinions, vulcanite, castings, oils, &c. Forms of tender can be obtained at the Tramway Offices, 7, Hall Ings, Bradford.

The GREAT NORTH OF SCOTLAND RAILWAY Co. require tenders by 10 a.m., Nov. 22, for six or 12 months' supply of stores and materials, including telegraph material, boiler tubes, steel, castings, ironmongery, oils, &c. Forms of tender from Stores Superintendent.

Tenders are required by CHESHIRE LINES COMMITTEE by Nov. 22 for year's supply of stores, including telegraph materials, carbons, oils, &c. Specifications from the Stores Superintendent, Warrington.

THE SLIGO, LEITRIM AND NORTHERN COUNTIES RAILWAY Co. require tenders by 10 a.m. Dec. 1 for 12 months' supply of stores, including telegraph materials, rubber goods, brass, copper, zinc, tools, wire, &c. Forms of tender from the Secretary, Enniskillen.

Cooling Towers.

MANCHESTER Electricity Committee require tenders by 10 a.m., Dec. 12, for the supply and erection of three fan draught cooling towers at Stuart-street electricity works. Specifications, &c., from Mr. F. E. Hughes, Town Hall, Manchester.

Flame Arc Lamps.

DUBLIN Electricity Supply Committee require tenders by noon Nov. 22, for the supply of 24 direct-current magazine flame arc lamps. Specifications, &c., from the City Electrical Engineer, Fleet-street, Dublin.

Electrical and General Stores.

THE TYNE IMPROVEMENT COMMISSIONERS require tenders by Nov. 22 for 6 or 12 months' supply of incandescent lamps, arc lamp carbons, rubber and asbestos goods, ironmongery, tools, varnishes, &c. Forms of tender from the General Manager, Berwick-street, Newcastle-on-Tyne.

COVENTRY.—The tender of Lee, Beesley & Co. has been accepted for wiring fitments for the domestic [illegible] at the Stoney Stanton road Hospital.

MANCHESTER.—The Corporation have accepted the following tenders:

Chamberlain & Hookham, for [illegible] hour meters; Ferranti (Ltd.), for single-phase watt-hour meters, and British Westinghouse Co., for polyphase meters. Orders have also been placed with Electric motors (Ltd.) and Ferranti (Ltd.) for [illegible] to 10 [illegible], with Ferranti (Ltd.), for current transformers, and with the British Westinghouse Co. for potential transformers.

SHEFFIELD.—The Council has accepted the following tenders in connection with the erection of the emergency power house at Blackburn Meadows:

[illegible]

WOLVERHAMPTON.—The following tenders have been accepted by the Corporation:

[illegible]

APPOINTMENTS VACANT.

[illegible]

A head clerk is wanted [illegible] *See advertisement.*

Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board require a shift engineer, with experience of steam turbines and three-phase supply (wages £3. 10s. per week); and a sub station attendant, with experience of rotary converters, motor generators and batteries (wages £2. 7s. per week). Applications to Engineer-in-Chief, generating station, Tame Valley, Stalybridge.

Applications are invited for the position of Principal of the Coventry Municipal Technical School. Commencing salary £600. Particulars from the secretary (Mr. Frederick Horner), Education Department, Council House, Coventry. Applications by Dec. 1.

A teacher of engineering subjects is required for the day department of the Walthamstow Technical Institute. Salary £180, rising to £250. Applications by Nov. 20 to the Clerk to the Governors, 1, Selborne-road, Walthamstow, E. 17.

The Corporation of Leigh (Lancs) invite applications for the appointment of engineer and manager of their electricity department. Commencing salary £300 per annum. Applications to the Town Clerk by Nov. 23.

BUSINESS ITEMS.

Communications for Coventry electricity [illegible] should be addressed to the Council House, Coventry.

Patent Development.—The proprietor of patent No. 25,632, of 1905 relating to [illegible] or to grant licences thereunder. Applications to Messrs. Boult, Wade & Tennant, 111-112, Hatton Garden, London, E.C. 1.

The proprietors of patent No. 14,091 1912, for "an improved method of drying," desire to enter into negotiations for the grant of licences or for the sale of the patent.

Cables and Meters for Sale.—The Electricity Department of Salford Corporation advertise for sale [illegible] lated cable. Schedule of lengths, &c., and tender forms from the Borough Electrical Engineer, Frederick-road, Salford.

An advertiser has 56 Reason prepayment electric meters for sale.

Plant Wanted.—An advertiser requires a 600-kw. or 700-kw. direct-coupled Belliss engine and generator, [illegible] wound.

Messrs. Ruston, Proctor & Co. (Ltd.), Lincoln, advertise for a rotary converter for 230 to 460 volts direct-current.

The Haddon Caxton Engineering Works, Market Harborough, require two or three second-hand 10 [illegible]

LIQUIDATIONS, &c.

Claims against the [illegible] are to be sent by Nov. 30 to the liquidator, Mr. A. Page, 38, King street, Cheapside, London, E.C.

Winding-Up Petition.—A petition for winding up the Bosch Magneto Co. (Ltd.) will be heard at the Royal Courts of Justice, London, W.C., on Nov. 20. [illegible] Board of Trade, [illegible] Nov. 19.

CATALOGUES, &c.

[illegible]

for voltages up [illegible]

[illegible]

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Darlington. The accounts of the light railways and electricity departments were approved by the Council at its last meeting.

The [illegible] showed that traffic revenue was £15,048 (compared with £14,415 in the previous year) = 9·85d. (9·21d.) per car-mile. The net deficit for the year was £1,761 (£1,088). Car-miles run were 372,289 (381,956).

The electricity department's accounts showed units generated 7,277,119 (increase 31 per cent.). Cost per unit was 0·56d. (0·65d.), the lowest ever reached.

[illegible], in moving the adoption of the accounts, said of 200 towns in the United Kingdom there were only 10 in which the cost of electricity was lower than at Darlington and all those 10 had much larger outputs and better load factors. For the last 10 years the gross profit had never fallen below 10 per cent. on the capital outlay. During the last few years they had almost entirely changed their system of generation from low tension direct-current to high tension three-phase. This year they expected an output of not less than 10,000,000 units, and the load was still increasing. A large electric furnace had been recently set to work by one of their big power consumers and several other customers were also installing additional plant.

Kingston (Surrey). At the Council meeting last week the accounts of the [illegible] supply department were submitted.

The [illegible] capital expenditure at March 31 was £66,132 compared with £[illegible] at March, 1916. The net deficit for the year was £[illegible] against £629 in previous year. Consumers increased from 1,875 to [illegible] equivalent 32-watt lamps connected from 83,395 to 90,342. Units generated by coal were 757,980 (181,987) and by fuel oil 492,605 (974,220). Cost per unit was 4·618d. (3·622d.), while receipts per unit [illegible] from 3·491d. to 3·314d.

The Lighting Committee's report states that the principal reason for the heavy deficit is the greatly increased cost of fuel, owing to the large proportion of coal which has been consumed compared with fuel oil, as on account of the fracture of the crank-shaft of the two-cycle Diesel engine, that plant was out of commission during the whole of the year, and as a consequence the larger proportion of the units supplied were generated by the steam plant, and only the smaller proportion were generated by the remaining Diesel plant. The four-cycle horizontal Diesel engine has worked satisfactorily throughout the greater part of the year at a very low cost per unit generated. The units generated by steam cost in fuel 2·617d. per unit; while those generated by the oil plant only cost 0·421d. per unit.

COMPANIES' MEETINGS AND REPORTS.

AUCKLAND ELECTRIC TRAMWAYS CO. (LTD.)—The total revenue for the [illegible] June 30 was £286,886, and traffic receipts were £282,698, [illegible] £7,914 for the previous year. After meeting all expenses including £20,802 for debenture and other interest, the rental and percentage [illegible] payable to Auckland Council (£5,404) and setting aside £2[illegible] and depreciation account, the surplus is £55,317, making, with [illegible] brought forward, a total of £59,918. The directors [illegible] £[illegible] be transferred to reserve and that a further dividend [illegible] ordinary shares of 1s. per share (less tax) for the half-year [illegible] June 30, making 1s. 7d. per share for the year, and leaving £5,293 to be carried forward.

DRAKE & GORHAM (LTD.)—Mr. Bernard M. Drake, who presided [illegible] last week, said the past year's profit was £11,[illegible] £[illegible] for the preceding year. In the course of [illegible] he said that by adopting a conservative policy [illegible] had been able to enter new fields without having to raise additional capital, which would have been [illegible]. It was fortunate that the Board decided in the past [illegible] house lighting with which the name of the company [illegible] in spite of the practical [illegible] they had been able by manufacturing and [illegible] contracting for the equipment of war [illegible] considerably [illegible] possible. There was little doubt [illegible] electrical power [illegible] in which direction the [illegible] experience [illegible] after the war [illegible] The [illegible]

[illegible]

[illegible]

been adopted for use in France on a considerable scale. It had advantages over the ordinary tipping wagon, and could be fitted to existing vehicles. As the lease of the present warehouse and works was expiring they had taken the Rockingham Works, Newington, on lease. Manifestly, if the pre-war dumping was again to be permitted and the electrical industry was not to be fostered more than in the past, the manufacture of electrical goods would again show poor returns on capital invested. In view of the uncertainty they had not felt it wise at present to extend their manufacturing on the scale that they would have wished. However, they anticipated that in any event the wholesale merchanting branch at home and overseas would expand, and they were negotiating for a warehouse which should meet their needs for many years. They had a good list of orders for the first quarter of the current year, and were constantly receiving repeat orders from firms for which they had worked.

NAIROBI ELECTRIC POWER & LIGHTING CO. (LTD.)—The directors' report states that the number of units generated in 1916 was 1,495,281 against 1,122,744 in 1915; the motors connected, b.h.p., were equal to 648 b.h.p., against 431; and the lights connected (40-watts equivalents) were 9,811, against 8,044. The auxiliary steam plant at Nairobi was used to the extent of rather more than 10 per cent. of the total units generated. The preference and ordinary shares have been consolidated into shares of one class only. The operations of the Company have been carried on under continually increasing difficulties due to the war, and further developments are nearly stopped on account of the impossibility of procuring the necessary plant and materials for efficiently handling them at Nairobi. The directors declared interim dividends of 3 per cent each in respect of each half year, with a final dividend of 4 per cent., making altogether 10 per cent. paid for the year on all shares (less tax).

WESTERN TELEGRAPH CO. (LTD.)—The report of the directors for the year ended June 30, 1917, states that owing to delays arising from the war in obtaining the necessary returns from foreign stations and administrations and also to so many members of the permanent staff being on active service it was not until recently considered possible to present the accounts and balance sheet duly audited in respect of the year during the month of November when it has been customary to hold the annual general meeting. In these circumstances, the directors being satisfied that the net earnings for the year would be sufficient to justify an additional payment at the same rate as was paid for the previous year, decided to declare the usual dividend and bonus, warrants for which were accordingly posted on the 7th inst. The revenue for this period amounted to £1,073,295. 17s. 4d. and the working expenses to £397,890. 16s. 9d. After providing £32,747. for debenture stock interest, and £149,225. 14s. 7d. for income tax and excess profits duty, there remains £493,432. 6s.; to this is added £38,344. 13s. 2d. brought forward, making a total of £531,776. 19s. 2d. The directors have transferred £150,000 in further reduction of the amount of capital expenditure in excess of the share capital and debenture stock issued, £100,000 to general reserve fund, £30,000 to land and buildings depreciation fund and £50,000 to the maintenance ships reserve fund. Three interim dividends of 1½ per cent. each and a final dividend of 1½ per cent., also a bonus of 2 per cent. have been paid, amounting together to £166,344, making a total distribution of 8 per cent. (tax free) for the year, thus leaving a balance of £35,432. 19s. 2d. to be carried forward.

The 84th ordinary general meeting will be held on the 21st inst.

NEW COMPANIES.

RUSTLESS IRON (COWPER-COWLES PROCESS) (LTD.) (148,832).—Reg. Nov. 6, capital £5,500 in 5,000 7½ per cent. cumulative preference shares of £1 each, and 10,000 ordinary shares of 1s. each, to carry on any business connected with the manufacture of rustless iron and other metals, and the development of processes for preventing rust and corrosion, and to carry on the business of mechanical and electrical engineers, metallurgists, &c. Agreement with Sherard Cowper-Coles. First directors include Sherard Cowper-Coles.

TAYLOR & CO. (HATTON GARDEN) (LTD.) (148,833).—Private company. Reg. Nov. 6, capital £1,000 in £1 shares, manufacturers of and dealers in mica, micanite, electrical plant and accessories, insulating machinery, mica chimneys, lamp tops, &c.

CITY NOTES.

CENTRAL ELECTRIC SUPPLY CO. (LTD.)—The 4 per cent. guaranteed debenture stock transfer books of the company will be closed from the [illegible] to the 30th inst., inclusive, preparatory to the payment of interest due Dec. 1.

INDIAN ELECTRIC SUPPLY & TRACTION CO. (LTD.)—An interim dividend of 2½ per cent. has been declared.

STOTHERT & PITT (LTD.)—A dividend of 10 per cent. and bonus of [illegible] per cent. (together 2s. 6d. per share), tax free, has been declared on the ordinary shares for the past year. £[illegible],000 has been placed to reserve; £12,998 to [illegible] goodwill account; £2,000 to a fund for pensioning old employees. The bonus is distributed from the final instalment due on the contract completed prior to June 30, 1914, for the Brazilian Government.

THE ROUND TABLE.

By "KVA."

THIS WEEK'S CHESTNUT.—During the operations of the R.E.s in Palestine a Colonial padre found a body which he recognised as that of John of Antioch. He telegraphed to the Colonial authorities: "Have found body of John of Antioch; may I remove?" He received a reply: "He has been reported missing for some time; please send his identity disc!"

* * * *

A Newport correspondent sends me the following:—

A man who had applied for employment in our electricity department, but was rather dissatisfied with the terms, wrote as follows:—

"Sir: Your letter to hand. You needn't worry 'old kid'; I did not intend coming to see you anyway. A cold winter job and 28s. a week and pass a doctor's examination *et al.* you want a 'heluva' lot for your wages, cocky; more than I would give you, believe me, even if your tramway system ran to heaven!" I think this will take some beating, eh?

* * * *

Several Round Table readers have called my attention to a recent advertisement of a transformer maker in the current issue of the B.E.A.M.A. "Journal." It shows how the printer can quite unwittingly reverse important illustrations. The picture in question shows a transformer in its tank, complete with under wheels, *upside down*. At first glance the transformer might be designed for suspension on an overhead runway, presumably to facilitate inspection and repair. The reversal of the picture is all the more amusing because the type of transformer is fitted with a patent oil float, which I expect the designer, even in his wildest moments (and transformer designers do have wild moments) did not figure on for upside down operation! Still, printers have a keen sense of humour and its as well to let them display it sometimes.

* * * *

I am assured by a Birmingham trader, at one time in the electrical business, that the following story is true. Way back in the early days of the industry it was easy to get quite a good job in certain firms if one affected an American accent. It befell that one whom we will call Smith, for the nonce, obtained such employment with a firm of electrical manufacturers to "boss" the spare part department. He was "sized up" by the other members of the staff, who decided to pull his leg badly. One of them entered the telephone exchange at the office, and ringing up the [illegible] boss of the spare part department professed to be a firm of [illegible] in the city. He then gave out from his indents the following items, which were to be delivered at once in a tin-lined [illegible]:—

30 sets armature slots without [illegible]
5 gross [illegible] stray field No. 16 [illegible]
2 boxes V.I.R. eddy currents
1 drum of grease for armature reaction
2 polishing machines for pole tips
2 [illegible] copper [illegible] bolts for [illegible] round poles
2 dozen [illegible] nuts without [illegible]
6 sets of [illegible]
1 complete H.P.I.I.
1 [illegible]

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN, November 13, 1880.]

NICKEL PLATED LOCOMOTIVES.—The Plating Co., of the Bishopgate Lane Works, Stockton-on-Tees, are nickel plating the domes, valve covers, and other bright parts of seven locomotive engines for an English railway. This is something new in this country, but it will probably be in general use, as the finish is not only handsome, but the saving in labour and stores, such as oil and waste, is considerable.

"HORSE-POWER."—An American has invented a new kind of stable floor which, among other things, will, he thinks, be useful for driving dynamo-electric machines. The floor is an endless band of transverse slats, [illegible] upwards, and keeps the horse walking. A [illegible] the roller conveys this one horse-power to anything you please. When a suitable horse has been invented this machine will be perfect.

CONSTANTINOPLE.—We understand that Mr. J. Pender, M.P., the chairman of the Eastern Telegraph Co., who at present is visiting the stations of the Company in the Mediterranean district, was admitted to an audience with the Sultan at Constantinople on Tuesday, Nov. 9. Although Mr. Pender's principal object during this tour is the business of the Eastern Telegraph Co., at the same time he must necessarily obtain a great amount of valuable information directly and indirectly upon political questions. The impression Mr. Pender formed during his long [illegible] interview with the Sultan is that the ruler of Turkey has a strong desire to obtain an honourable settlement of pending questions, in order that he might give effect to a settled purpose of advancing the industrial and material development of the country.

Brazil.—It is reported that the [illegible] deposits recently discovered in the State of Minas Geraes are very rich, and their position near the Victoria Minas Railway is favourable. A single [illegible] has already yielded 15 tons per day [illegible].

The following are extracts from the message addressed by the Legislative Council on Jan. 17 to the President of the State of São Paulo (Dr. A. Arantes).

Public Lighting at São Paulo.—There has been [illegible] electric lighting, which is supplied by 850 [illegible] incandescent lamps of 600 [illegible]. The State [illegible] electric lighting of certain [illegible] with the Light and Power Co. [illegible] electric lighting of the streets [illegible] capital. [illegible] will be concluded [illegible] contract [illegible] been signed on Feb. 13 last.

Telephones.—During the year [illegible] telephone lines.

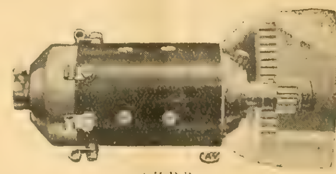
[illegible]

Electric Steel Works in Germany.—[illegible]

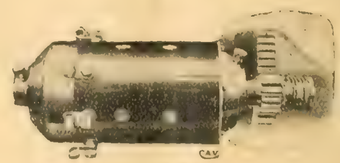
"C.A.V." ELECTRIC STARTERS.

Messrs. C. A. Vandervell & Co., Ltd., Acton, London, W., who are well-known in the motor world for their enterprise and progressive spirit, have recently placed upon the market a new geared type of electric starter. The improved starter is driven by toothed gear, of which the main feature is the ingenious arrangement for throwing the pinion into and out of gear. The pinion is mounted upon a screw thread on the end of the starter spindle. A switch, operated by the foot, controls the starter, and has two positions, the first of which has the effect of drawing the armature along endways by magnetic attraction, which movement causes the teeth of the pinion to bear against those of the wheel, while the starter is made to rotate slowly. The ends of the teeth towards the wheel are tapered off so that they will fit into gear in almost any position, and so soon as they get into mesh the pinion is stopped while the starter spindle continues to rotate, thereby screwing the pinion along into full gear. A further depression of the switch pedal runs

"Z.C."



"Z.B."



"Z.A."

the starter at full speed and starts the engine. As soon as the engine starts the pinion is run in the opposite direction and unscrews along the spindle out of gear. The following are the leading features of the starter:

The pinion of the starter motor is noiseless and automatic when engaging the gear on the fly-wheel; it does not in any way rely upon speed to effect proper engagement. It is only possible to apply the full power of the motor when the gears are fully meshed. No damage can result from anything in the nature of backfires. The disengagement or release of the pinion is absolutely automatic and certain immediately the engine starts. It has nothing in the nature of an over running clutch, and there is no resistance switch with its consequent possibility of burning out. It has no chain to stretch, necessitating adjustment. Its efficiency is remarkable, the current consumption being extremely low. It is exceptionally light, and combines strength with simplicity.

The starters are made in three sizes, and the above illustrations give a good idea of the relative sizes of the series of "Z" type starters. The small model known by the symbol "Z.C." is suitable for starting motors up to about 16 H.P. The medium size model which is known by the symbol "Z.B." is suitable for use on cars up to about 40 H.P. The largest model of the series is known by the symbol "Z.A." and is capable of starting the most powerful engines fitted to cars, while it is also suitable for marine type of engine up to about 150 H.P. This range of starters will be found to cover all ordinary requirements in connection with starters for internal combustion engines in general use upon road vehicles as well as for aeronautical and marine work.

HIGH-FREQUENCY ELECTRIC FURNACE.

The "Electrical World" states that a furnace which presents a radical departure from usual furnace practice and embodies the first employment of oscillatory currents for the generation of heat and production of temperature has been placed on the market by the Pyrolectric Instrument Co., of Trenton, N.J.

By reason of the highly effective induction possible without the interlinkage of a magnetic with an electrical circuit, currents can be set up in the containing crucible in the case of a non-conducting melt, or in the melt itself if this melt has sufficient conductance to permit the flow of current. It is pointed out that no iron is used, and thus it is possible to raise the temperature of a melt in a crucible until its resistance becomes low enough to permit the generation of heat in the substance itself, after which the temperature producible is limited only by the durability of the insulation and refractory container. Since the furnace operates by induction, conditions of the melting chamber may be controlled perfectly. Consequently it is possible to produce temperatures exceeding 1,600° C. in the partial vacuum or pressure, with any conceivable atmosphere, and, if desired, without the contaminating influence of carbon. The furnace works on a two-phase commercial circuit, 60-cycles, 220 volts, with balanced load at unity or slightly leading power factor, and it has been developed by Dr. E. F. Northrup, in conjunction with the Pyrolectric Instrument Co., under the direction of the Ajax Metal Co. of Philadelphia.

SCIENCE IN THE METAL TRADES.

Prof. T. Turner, who recently delivered a lecture at the Birmingham University on "The Scientific Spirit in the Metal Trades," emphasised the difference between a knowledge of facts, important though they might be, and the truly scientific spirit. Science organised and classified our knowledge, so that a man was able to reason from what was ascertained to what was unknown, and thus for practical purposes his memory was vastly extended. He remembered laws and principles instead of isolated instances. Metallurgists were both searchers and workers, and the researches of the early metallurgists had greatly contributed to scientific development.

The metal trades of Birmingham had gradually grown up during the last two centuries, and were still largely unorganised and unduly competitive. The scientific spirit would be applied in the first place to the study of the properties of the materials, in their raw state and throughout all the processes of manufacture and of use. But side by side with this more strictly metallurgical study must go the study of commercial conditions and of the conditions of labour. The result of such study led to cheaper and more uniform production, with specialisation in particular directions, but also to improved conditions of labour. Ultimately no manufacture would flourish which did not satisfy both those who bought and those who were engaged in the manufacture. There were two obvious directions in which the scientific spirit could be encouraged. Firstly, the young must be trained so as to fit them for their employment. No system could be satisfactory which was not based upon the support of the manufacturers, and which was not headed by the university, or by training of a university type. Not that any large proportion of the working population could actually go to a university, but provision should be made for those who were qualified. Secondly, trade or scientific societies were necessary in order to provide opportunities for intercourse and for extending information. One of the most useful of those societies to the local metal trades was the Institute of Metals, which, since it held its first meeting in Birmingham in 1908, had increased in membership fivefold, and was now the recognised centre of information in connection with the non-ferrous trades.

DOMESTIC ELECTRIC HEATING PROGRESS IN CHICAGO.

The methods adopted by the Commonwealth Edison Co., of Chicago, for popularising the use of electricity for domestic purposes are typical of those of most progressive utility companies in the United States, and therefore we give an outline of this company's procedure.

For several years the Commonwealth Co., as a part of its summer programme, has hired a large number of college men and experienced canvassers to conduct a house to house canvass to sell heating devices on easy terms. The salesmen are usually employed on a drawing account per commission basis, and they work in crews accompanied by a wagon and an experienced man, who is in the regular employ of the company. This year the campaign extended from June 15th to September 15th, with an average of 40 men working from four wagons on the job. The "Electrical World" reports that on September 11th, when the campaign had four days to run, the total sales of the different devices were as follows:—Egg cookers, 83; percolators, 1,7[illegible]6; irons, 16,090; toasters, 1,2[illegible]3; total 19,202. The egg cookers, which were of the hotpoint type, were sold for $3.40; the percolators, which were Universal and hotpoint equipment, were sold for $4.75; the General Electric toasters were sold for $3.9[illegible], and the irons, which were of many different makes, were sold

for $3.50. The success of the year's campaign is said to be due to improved advertising and to the thriftiness of that class of housewives which was interviewed. The canvassers in their house-to-house work did not enter the city's high-class residential and apartment house districts, but strove rather to reach the home of the average wage earner.

BOILER TUBE VACUUM CLEANER.

In a recent issue of the "Electrical World," particulars are given of an electrically operated vacuum system for boiler cleaning.

At a sub-station of the Worcester (Mass.) Electric Light Co. four 150 H.P. steam boilers are employed to supply steam heat to some stores and offices. The boiler plant formerly supplied high-pressure steam to an isolated plant, but when the service was taken over by the company the demands for high-pressure steam were virtually eliminated.

The introduction of the electrically-operated vacuum system for cleaning the tubes has saved from $45 to $50 per month in fuel, as it is no longer necessary to run the steam pressure up to 150 lb. to blow out the tubes. The cleaner is of the Spencer turbine type, and is rated at 7·5 H.P. A 2 in. (5·1 cm.) pipe is run from the boilers to a vertical tank in an alley outside the sub-station, and all tube debris is delivered into this tank, provision being made for the removal of soot and dirt. The withdrawal of soot from the tubes is effected by attaching a metal hose to a service outlet and inserting a special nozzle into the tube end. The nozzle is equipped with a flange, which covers the tube and ensures a satisfactory vacuum. The nozzle consists of a piece of pipe about 4 ft. long, held by two brackets fitted with wooden handles to protect the fireman from the heat, which is too great to permit grasping the nozzle itself. With the equipment cleaning of a boiler can be done within 10 minutes, with the fire banked or with the boiler cold. It is estimated that at least 500 lb. (226·8 kg.) of coal is saved daily in the plant. The tubes are given the "vacuum treatment" each morning about four o'clock, the boilers being banked from 11 p.m. to 5 a.m. The tube conditions are much improved, inspection showing them to be clean and bright, instead of dull and dirty, as was the case after employing the old methods of cleaning. The fire room is much more comfortable, smoke is reduced, and the insurance premium has been reduced $15 per year.

CONCENTRIC WIRING.

At the annual meeting of the International Association of Municipal Electricians, which was held at Niagara Falls (N.Y.) last month, a resolution against concentric wiring was adopted.

The resolution stated that "bare grounded-return wiring systems have great demonstrated disadvantages and no demonstrated advantages from the standpoints of life and fire hazard as compared with present systems of wiring in this country, and that they do not comply with the rules of the National Electrical Code and the National Electrical Safety Code, which meet in a satisfactory degree all conditions obtaining in this country for the best protection of life and fire hazard conditions in step with the progress of the electrical industry. The association, therefore, unqualifiedly endorsed the findings and report of the electrical industry sub-committee on bare grounded-return wiring systems."

THE ELECTRICIAN:

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CONTENTS.

NOTES.

Higher Efficiencies in the Boiler Room.

THE close attention now being devoted to economy in fuel leads one to emphasise the view that there are great opportunities for improved methods in the boiler-room, a section of the generating station that hardly seems to have yet received the scientific treatment bestowed on the electrical side of generation. It is not only in the plant for conversion of heat energy into steam that improvement is possible: the training of those in charge of such plant is, perhaps, even more conducive to economy. This point is well put by Mr. J. G. WORKER, in an article in the "Electrical Review and Western Electrician," when he says:—

It requires men of intelligence and good judgment to supervise fuel economy, and the end desired will never be attained as long as we hold the old idea that the requisites of good firing are brawn and a strong back.

Possibilities and Actual Results.

IN considering possible savings in a boiler room a distinction should be drawn between improvements in equipment and in operation. The necessary losses in the generation of steam are under certain conditions from [illegible] to 10 per cent. of the total heat value. The highest theoretical efficiency is thus 90 to 92 per cent., and in practice [illegible] grate and boiler efficiencies of 75 to 80 per cent. are not unusual. Mr. WORKER remarks, however, that on the average an operating efficiency of only 60 per cent. may be expected in the United States, and [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] kilowatt-hour, though it [illegible] kind of fuel. The result is ascribed to improvements in turbines, boilers and stoker equipment, as well as methods of operation, but the latter were probably important factors. The most progressive stations in this country can, of course, point to considerably better results than this figure. Nevertheless, we agree that there is room for more scientific method, especially in the training of those responsible for operating the boiler house. It is in this part of the power house that the investment of salaries finds its best return.

A University for Research.

WE notice that a Bill to create a national university for promoting research was [illegible] Congress of the United States, and that a similar Bill will probably come before the present Congress next month. The proposed university has some unusal features. One of the objects of the recent Bill was to provide instruction in foreign trade, diplomatic and consular service and international law, in addition to [illegible] subjects. With regard to the scientific aspect, the objects in view were to promote the advancement of pure and applied science, to provide for higher instruction appertaining to posts of importance in the State and to co-operate with scientific departments of the Government and with institutions of higher learning. The university was not to be one for conferring degrees; in fact the holding of a degree was to be a preliminary condition to admission. Government museums, libraries and laboratories were, as far as possible, to be open to students. This is certainly a novel step, but we have some doubt as to the desirability of a university of this kind, which we should rather [illegible]. By all means have a research institute, but in that case we think it will be better to have it entirely free from questions of teaching. If the universities are to play a serious part in research, as they certainly should, then they will probably be most effective in this direction if departments are formed exclusively for research, such departments being open to advanced students taking post-graduate courses and to such other scientific workers as may be properly qualified. Universities in this country are already doing a great deal of work in this direction, and it only requires [illegible] to make the [illegible] of any university very effective, thus utilising the departments which are already formed, and thus available, in all the cognate branches of science.

The Limitation of Imports and Exports

[illegible]

maintained in a stable state immediately after the war when conditions will be changing very rapidly. A period of three years will give the necessary time for adjustment to take place and for our industries to recuperate themselves. It will also prevent our being flooded by goods of enemy origin. In regard to exports also it is highly desirable that we should be in a position, for example, to limit the export of our coal so that it may be utilised more thoroughly for our own requirements, particularly if low temperature carbonisation is to be developed. There will probably be doubts on the part of free-traders as to the desirability of such a policy, but we trust they will see good reason to modify their views for the time being under the present unusual conditions.

The Nobel Prizes.—The Stockholm Academy of Science has decided not to award the Nobel Prize for physics and chemistry for the years 1916 and 1917. The prize for 1917 will be reserved until next year.

The Goods Clearing House.—We understand that Sir Albert Stanley, President of the Board of Trade, will to-day receive a deputation which will urge him to investigate the possibilities of the goods clearing house system, proposed by Mr. A. W. Gattie. The deputation will be introduced by Mr. Walter Roch, M.P. for Pembrokeshire, and among those present will be Mr. Goodman, representing Mr. Hughes, Prime Minister of Australia, who desires to examine the whole scheme of the New Transport Co.

Electric Lights to Mark Aerial Trial Routes.—Electrical companies and town councils in the United States are offering to provide the "lighthouses" necessary to mark the aerial routes between Dayton, Ohio, and Indianapolis, Ind., and other cities to be used by the aviation corps of the United States Army in training students for this service. Searchlights will be turned upward each night to guide aviators on their way during the training period in making night flights. Dayton is to be equipped with the most powerful set of searchlights that can be procured in the United States.

Royal Institution of Great Britain.—The usual Christmas course of six juvenile lectures will this year be delivered by Prof. J. A. Fleming, D.Sc., F.R.S., the subject being "Our Useful Servants: Magnetism and Electricity." The individual lectures will be as follows: "Magnets and the Magneic Compass," on Thursday, Dec. 27th; "Electricity and Electric Currents," on Saturday, Dec. 29th; "The Electric Current as a Heater and Chemist," on Tuesday, Jan. 1st; "Electricity as an Illuminator and Doctor," on Thursday, Jan. 3rd; "Electric Dynamos, Motors, Transformers and Railways," on Saturday, Jan. 5th; and "Electric Telegraphs and Telephones," on Tuesday, Jan. 8th.

Periscope for Reading Transformer Temperatures.—The "Electrical World" mentions an interesting device used in operating [illegible]. In order to read the temperature of [illegible]

I.E.E. Discussion on the Metric System. [illegible] I.E.E. Discussion is to consider the effect on the British electrical trade of the introduction of the metric system at the present time, more especially in those markets in which the British system is at present in vogue, with a view to determining whether the compulsory introduction of metrical measures should be pressed for or resisted. It is hoped that it may be found possible to take steps after the discussion to obtain some authoritative pronouncement on the matter from the trade as a whole that will put an end to the present hesitating and unsatisfactory attitude towards the question.

Swiss Legislation on Hydro-Electric Power.—The general coal-shortage has affected Switzerland in a peculiar degree. This country, having practically no coal resources of its own, is largely dependent on Germany, which will only sanction the export of her own coal in return for specified imported goods. This situation is a highly inconvenient one, apt to lead to friction with the Allies, and Switzerland is therefore making every effort to develop her water-power so as to minimise the need of fuel. The "Revue Générale de L'Electricité" publishes in detail the new law passed by the Swiss Government relating to the utilisation of water-power. The law deals mainly with the conditions under which concessions to work water-power can be obtained, and the measures designed to protect local rights. The law is, however, specially framed to facilitate the exploitation of hydraulic power, and is regarded as an improvement on the measures hitherto in force.

Electric Heat Storage in Boilers.—In a recent issue of "Engineering," an account is given of a new type of electrical steam generator invented by Col. Revel, an engineer in the Italian army. The essential idea in the apparatus is the direct conversion of electric energy into heat by making use of the resistance of the water to be evaporated. Alternating circuits of 200-3,600 volts can be applied, and this apparatus is stated to be automatic and to require no regulation. Lack of feed water merely diminishes the production of steam until the supply of water is renewed. The efficiency is claimed to be 97-98 per cent. The Revel apparatus is constructed to work at pressures up to 14 atmospheres, and can be connected up at any time to the steam pipes of an ordinary boiler. In this way temporary use can be made of hydro-electric supplies, and their utility can be judged by the fact that they were often used even before the war when the price of coal in Italy did not exceed 32s. a ton. An illustration is shown of an installation of eight generators taking three-phase current at 6,000 volts, and each developing 900-1,000 kg. of steam per hour. The production of steam varies according to the area of electrodes immersed. The sediment collecting at the base of the apparatus from water containing calcareous material can be released without interrupting the process.

Institution of Electrical Engineers.—WESTERN LOCAL SECTION. The first meeting of the Session was held at Cardiff on Monday, Nov. 12.

Mr. R. Howard Fletcher, on being inducted to the Chair for the ensuing session by Mr. W. A. Chamen, received a cordial welcome from the very satisfactory audience which had mustered. In asking Mr. Fletcher to take the chair, Mr. Chamen alluded to the absence of Prof. D. Robertson (the retiring chairman), and referred in eulogistic terms to the interest Prof. Robertson always evinced in anything appertaining to the Western Local Section. Physical inability alone prevented him from [illegible] Cardiff. The vote of thanks to the retiring Chairman, proposed by Mr. D. Roberts and seconded by Mr. A. J. Newman, was carried with hearty applause. A cordial reception greeted Mr. R. Howard Fletcher on rising to give his sessional address (reported in our [illegible]), which was followed by a great amount of interest. At the close of the address, Mr. W. A. CHAMEN, having obtained permission to [illegible], remarked that the address had presented such a variety of points of interest to the industrial community at large, that, in his opinion, it should be ventilated in the public press. He stated that a great deal of the present unsatisfactory relationship between employers and employees could be alleviated if not actually removed by the men [illegible] appreciating that the employers were not making the supposed enormous profits at the expense of the employees' labours. He [illegible] point where dissatisfaction was immediately removed when the men were informed of the true state of affairs. Mr. [illegible], in continuing the discussion, remarked that some legislation ought to be [illegible] to enforce the obligations of the men as well as the employers in any dispute that might arise, and until this came about he could not see how conditions could very much improve. The vote of thanks to the Chairman for his able address was carried with acclamation.

The Telephone as a Test of Deafness.—The "Telephone Engineer" describes a number of devices for ascertaining the extent of deafness arising through constant exposure to detonations, &c., in the Army, and for detecting the wiles of malingerers. Some of these are designed to deal with unilateral deafness, while others are based on the interference of sounds in the vicinity which react differently on people who are deaf and those who have normal hearing. The most complete testing device, however, is an apparatus permitting the progresssive variatiòn in the intensities of sound in two telephone receivers. By the aid of this apparatus, the power of hearing in each ear can be determined at different times and in a genuine case of deafness the results should be consistent. The apparatus is also useful for observing the effects of treatment.

West of Scotland Iron and Steel Institute.—At the opening meeting of the current session on Friday, the president (Mr. Herbert Beard) said the institute attained its semi-jubilee this year, and as far as membership was concerned it was the largest of the provincial iron and steel institutes.

The British steel industry had made wonderful strides since the war began, but it would have to get more ore, more pig iron, and more scrap if it was to supply what was required to make up shipping losses. To make our shipping losses good was one of the biggest tasks that ever confronted the shipbuilders and steel manufacturers of Great Britain, and it would tax the rolling capacity of the steel works for a long time ahead. In regard to the question of industrial research and to the proposal for the formation of a research association in Scotland, he said the Council of the Institute looked with favour upon the proposal, which would have the hearty support of all the principal iron and steel manufacturers and engineers and shipbuilders.

Mr. Cecil H. Desch, D.Sc., afterwards spoke on "Industrial Research," which was one of the principal problems of industry. In the keen competition among nations something more than individual initiative was necessary. Organised co-operation was needed. Greater individual initiative and organised co-operation was necessary than there had been in the past. Well equipped laboratories, with conpetemt staffs giving themselves exclusively to research work, were essential, and it was desirable to associate these with existing education institutions. Dr. Desch afterwards described methods of research in America and elsewhere.

Spontaneous Combustion.—Mr. G. H. P. Walker, in a recent publication issued by the National Fire Protection Association (U.S.A.), deals with some common cases of so-called "spontaneous combustion," which depends essentially on chemical action attended by the liberation of heat. In such changes oxygen is usually, though not necessarily, involved. The velocity of combustion increases very rapidly with the temperature, a rise of 200° F. increasing it at least ten thousand fold. One of the commonest causes of spontaneous combustion is the ignition of pieces of cotton waste or old rags saturated with oil and allowed to remain in a warm place. Among the oils which are most prone to produce spontaneous combustion is linseed oil, especially the boiled variety, the ignition being due to the oxidation of a thin film of oil presenting a large surface for combustion. The absorption of oxygen leads to rise in temperature which in turn hastens the chemical process until eventually the ignition point is reached. Mineral oils are much less dangerous in this respect. Other forms of spontaneous combustion are due to the presence of finely suspended particles of more or less combustible substances in the air, such as the dust of pyrites or organic matter such as [illegible].

"The Coupling Coefficient of Coaxial Flat Spiral Coils."—ERRATUM. Our attention has been drawn by Mr. G. B. [illegible] to some errors in this article and we have now heard from Prof. Barlie that certain expressions should read as follows:—

1. The expression for q on page [illegible] should be

$$q = \int [illegible]$$

instead of printed value

$$q = \int [illegible]$$

2. Values given by the curves in Fig. 4 and spoken of as "values of M in terms of D/E and D'/E," [illegible] M in terms of D/E and D'/E, when $E = 10$ cm. Since M has the dimension of a length it may be said, if preferred, that M is to be obtained from curves in Fig. 4 by multiplying by $L/10$ (L being in centimetres). This is the case where E is not 10 cm.

3. A wrong value of k^2 is printed on page 975 (bottom of column 1); k^2 is obviously equal to

$$\frac{AB^2 - AA'^2}{AB^2} \text{ and not } 1 - \frac{AB^2 - AB'^2}{AB^2}.$$

It is also quite obvious that the value given on page 976,

$$k = \frac{1}{[illegible]},$$

is erroneous. It should read

$$\frac{1}{k^2} = \frac{1}{[illegible]} \text{ or } k^2 = 1 [illegible]$$

as indicated by Mr. Ehrenborg.

OBITUARY.

PETER DENNY.—We have to record the death on the 19th inst. of Mr. Peter Denny, the well-known engineer and shipbuilder, of Dumbarton, at the age of 64.

PERSONAL.

FRENCH HONOURS.—H.M. the King has granted to Sir John Hunter, K.B.E., Director of Factory Construction and Director of Iron and Steel Production, Sir Leonard W. Llewelyn, K.B.E., Controller of Non-Ferrous Materials Supply, and Mr. Wm. J. MacLellan, officials of the Ministry of Munitions, leave to wear the Cross of the Chevalier of the Legion of Honour, conferred upon them by the President of the French Republic.

On the 14th inst. at Christ Church, Ecclesall, Lieut. Walter J. Cridge, 15th Sherwood Foresters, who is now attached to the Central Clearing House, Ministry of Munitions, was married to Honor Isabel (Belle), second daughter of Dr. William Collier, of Ecclesall, Sheffield.

Mr. H. R. Forbes Mackay, [illegible] of Sydney (N.S.W.), has started on a visit to the United States and Canada in order to make himself acquainted with [illegible] and to inspect the principal [illegible] in the United States and Canada.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, Nov. 23rd (to-day).

[illegible]

MONDAY, Nov. 26th.

[illegible]

TUESDAY, Nov. 27th.

[illegible]

FRIDAY, Nov. 30th.

[illegible]

PYROMETERS AND PYROMETRY.

(*Continued from p. 229.*)

In continuation of the account in our last issue of the discussion held by the Faraday Society we now give an abstract of the Paper by Messrs. Griffiths and Schofield.

PYROMETER STANDARDISATION.

BY EZER GRIFFITHS, D.SC., AND F. H. SCHOFIELD, B.A., B.SC.

The increasing demands of the industries for temperature measuring and recording appliances have greatly stimulated progress in pyrometer construction, with the result that at the present day it is possible to measure temperatures over a very wide range—from that of liquid air to molten steel—with robust pyrometers of ample sensitivity.

It is now generally agreed upon that the standard scale of temperature should be the thermodynamic. This permits of the evaluation of high temperatures, on the basis of the radiation laws, on a scale consistent with that obtained by means of the gas thermometer at lower temperatures.

A "perfect gas"* would give a scale identical with the thermodynamic, while that obtained by the use of the more permanent gases—nitrogen, helium and argon—requires a small correction to convert to the thermodynamic scale. It will be seen, then, that the ultimate scale of temperature is that of a gas thermometer suitably corrected.

Hence the problem of pyrometer standardisation resolves itself to an empirical calibration of the pyrometer, whether mercurial, thermo-electrical, or radiation, by comparison with a gas thermometer. In practice the scale of the gas thermometer is preserved by means of auxiliary standards—the mercurial thermometer, thermo-element, or resistance thermometer, or by a series of freezing-points or boiling-points of pure substances.

So the steps by which the scale of a pyrometer is obtained are generally as follows: (1) The gas thermometer worker makes a comparison of his instrument with a thermo-element; (2) this calibrated thermo-element is then employed to determine the freezing-points of a number of pure metals; (3) the observer who wishes to calibrate a pyrometer, standardises a thermo-element by freezing-point determinations, assuming the values given by the gas-thermometer worker for these transition points; (4) the pyrometer and thermo-element are then compared under suitable conditions.

THE GAS THERMOMETER AND THE INTERNATIONAL SCALE OF TEMPERATURE.

For nearly 100 years researches on gas thermometry have been in progress almost without interruption, and the range $-200°$ to $+1,600°$C. has been traversed.

The practical difficulties of gas-thermometer work at high temperatures are very considerable. An effort was made to arrive at international agreement as to the adoption of a uniform temperature scale by the three national standardising laboratories†; but the outbreak of war prevented formal acceptance of a common scale of temperature.

The National Physical Laboratory decided to adopt for its own purposes, from the commencement of 1916, as its fundamental scale of temperature, the centigrade thermodynamic scale. The following alternative methods have been adopted as a basis for attaining a practical or working scale of temperature:

The Hydrogen Scale.—In the interval between 0°C. and 100°C., the practical scale is realised with the exactness required for work of the highest precision, in the scale of the constant volume hydrogen thermometer, having for fixed points the temperature of pure ice melting under normal atmospheric pressure (0°C.), and that of the vapour of distilled water in ebullition under normal atmospheric pressure (100°C.).

The Platinum Resistance Thermometer.—In the interval between the freezing point of mercury and the boiling point of sulphur the practical scale is realised with sufficient exactness by the platinum resistance thermometer standardised at the temperature of melting ice (0°C.), of the vapour of water boiling under normal atmospheric pressure (100°C.), and of the vapour of sulphur boiling under atmospheric pressure in a special form of apparatus and under specified conditions. The temperature of the vapour under these conditions is taken as being 444·5°C. The temperature t on the international scale is deduced from the resistance of the platinum thermometer by the formula,

$$t - pt = \delta\left\{\left(\frac{t}{100}\right)^2 - \frac{t}{100}\right\},$$

where $pt = 100 \times (R - R_0)/(R_{100} - R_0)$, and R, R_0 and R_{100} are the observed resistances of the thermometer at temperatures t^0, 0^0 and $100°$ respectively.

The boiling-point of sulphur T_s at pressure p millimetres is connected with that at standard pressure, 760 mm., by the formula

$$T_s = 444{\cdot}5 + 0{\cdot}0908(p-760) - 0{\cdot}000047(p-760)^2.$$

Over the interval 0°C. to 100°C., the scale thus defined is believed to be in agreement with the hydrogen scale of the International Bureau within the limits of experimental error required in most practical thermometric work.

The Fixed-Point Scale.—The practical scale is also realised with sufficient exactness by the use of the following fixed points, in addition to the three fundamental points above specified:—

	Temperature on the Thermodynamic scale.
Boiling-point of oxygen	$-182{\cdot}9_5 + 0{\cdot}01258(p-760) - 0{\cdot}0000079(p-760)^2$
Boiling-point of carbon dioxide...	$-78{\cdot}5 + 0{\cdot}01595(p-760) - 0{\cdot}0000111(p-760)^2$
Freezing-point of mercury	$-38{\cdot}88$
Transformation-point of sodium sulphate............................	$32{\cdot}38_4$
Boiling point of naphthalene......	$217{\cdot}9_6 + 0{\cdot}058(p-760)$
Boiling-point of benzophenone ...	$305{\cdot}9 + 0{\cdot}063(p-760)$
Melting or freezing-point of:—	
Antimony	630
Silver (in reducing atmosphere)	961°
Gold	1,063
Copper (in reducing atmosphere)	1,083°

Fixed points of the second order are provided by the melting or freezing-points of tin ($231{\cdot}8_4°$), cadmium (320·9°), zinc (419·4°), common salt (801°).

At temperatures exceeding 1,100° but few investigations have been made with the gas thermometer.

The value 1,549°C. was obtained by Day and Sosman for the melting-point of palladium, for which Holborn and Valentiner gave the value 1,575°.

Temperature measurements above 1,000° with a platinum alloy thermo-element in the presence of iridium are rendered untrustworthy on account of the great contamination caused by the volatile iridium. Moreover, it is necessary to employ a thermo-element to transfer the scale, since the practical difficulties of determining freezing-points at high temperatures directly by means of the gas thermometer appear to be insuperable.

The following values for "fixed points" above 1,100° were determined by Day and Sosman: Nickel, 1,452°; palladium, 1,549°; and platinum, 1,755°, by extrapolation of the thermo-electric formula of their platinum-platinum-rhodium couples.

Further research has shown that the temperature E.M.F. relationships for thermo-elements will not bear extrapolation over long intervals, and consequently such determinations are now obsolete.

THERMO-ELECTRIC PYROMETERS.

The working standards are calibrated by determination of their E.M.F. at a number of well-established temperatures—the boiling-points of water, naphthalene, diphenylamine and sulphur, and the freezing-points of tin, zinc, antimony, silver, gold, copper, nickel and palladium.

The boiling-points are determined in the usual Meyer tube form of apparatus introduced by Callendar and Griffiths for the standardisation of resistance thermometers at the sulphur boiling point or the N.P.L. modification shown in Fig. 1.

In the case of metals, other than gold and palladium, cooling curves are taken with the sheathed couple immersed in the molten metal. The cold junction is maintained at 0°C. by immersion in ice, whilst the E.M.F. is measured by a thermo-electric type of potentiometer. The crucible containing the metal is heated in a blast muffle and precautions taken against oxidation, &c. Ample depth of immersion should be given, and melting points and freezing points should agree closely.

The determination of the freezing point of nickel present exceptional difficulties, and consideration of expense preclude the possibility of taking cooling curves for gold and palladium. The wire method is convenient for these metals. In this the arms of the

* [illegible]

† National Physical Laboratory, National Bureau of Standards, Washington, [illegible] Reichsanstalt.

couple are joined up with a short loop of the metal. The thermo-element is then heated in a carbon spiral furnace with a liner tube of glazed porcelain, and its E.M.F. determined at the time of the breaking of the circuit.

The authors have recently endeavoured to find some freezing-point which would be easily reproducible and would help to bridge the gap between the copper and nickel points, and which would be obtained with the type of apparatus employed for the freezing-points of the metals. A mixture of nickel and graphite exhibits a well-defined eutectic with a freezing-point about midway between the two points. A specimen of the cooling curve for the eutectic, obtained in the usual way by immersing a sheathed thermo-junction in the mixture, is shown in Fig. 2.

A provisional value of 1,330°C. may be given for the freezing-point.

Temperature-E.M.F. Relationship.—Various empirical formulæ have been proposed for expressing the relationship between the E.M.F. and temperature of a platinum alloy thermocouple. No single expression of workable size holds over the complete range 0° to 1,600°C. The simplest procedure is to compute a table which represents a smooth curve through the experimental points. The values of the E.M.F. for every 10°C. are then set out in tabular form. From 200°C. to 1,000°C. a cubic curve represents the results quite closely, while above that temperature a parabola fits the observations.

Calibration by Comparison with a Standard Thermo-element. — The method of standardising by freezing-point determinations should only be resorted to in the case of primary working standards. The calibration of one couple by direct comparison with another is both simple and expeditious.

Our general procedure is as follows. The heavy porcelain sheath is removed and the thermocouple wires are insulated by capillary fire-clay tubing or quartz. The junctions of the two couples are tied together by a piece of pure platinum wire and inserted at the midpoint of an electric furnace. The couples are carried in a liner tube supported from the cold ends of the furnace to avoid leakage from the heating circuit into that of the potentiometer.

The E.M.F.s of the couples are determined at a series of steady temperatures over the range.

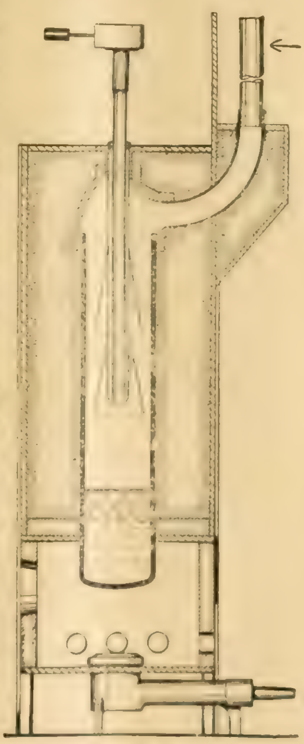

FIG. 1

Sources of Error in Thermo-electric Pyrometry. [illegible] The inherent defect of platinum [illegible] thermocouples is their liability to become contaminated. [illegible] element most rigorously from [illegible] carbonaceous matter at high temperatures. [illegible] appear to contaminate, [illegible] other materials which yield [illegible] which must be avoided. In [illegible] secure ample protection by the use of [illegible] sheath, with, of course, the [illegible] time lag in the observations.

A form of contamination which [illegible] completely is the volatilisation of platinum [illegible] on to the pure platinum limb. [illegible] with the rhodium [illegible]

Among the various methods of [illegible]

couples, that adopted by White, of the Geophysical Laboratory in America, is perhaps the most convenient.

(*b*) *Lag.*—The necessity of protecting the element from furnace gases, &c., by the use of a porcelain tube introduces another source of error when determining varying temperatures, namely, thermometric lag. This time-lag can only be reduced by sacrifice of robustness of construction.

With base-metal pyrometers for temperatures up to 800°C. it is possible to work with the exposed elements or with the wires simply coated with a thin layer of asbestos-cement mixture, and so reduce lag to a minimum. Time lag is apt to be very troublesome when determining casting temperatures of molten metals.

(*c*) *Oxidation.*—The defect of base-metal thermocouples is the gradual oxidation of the metal, which, of course, increases the resistance. It is the common practice to employ a low-resistance indicator with this type of pyrometer, so as to obtain robustness. Hence change in the resistance of the wires by oxidation of the couple affects the total resistance of the circuit. Errors of as much as 50°C. at 600°C. may be due to this cause, although the E.M.F. of the couple was unaltered when measured on a potentiometer.

In this arrangement two parallel wires of the same material (say, copper) are fixed at a certain distance apart and are maintained at different temperatures. The wire to be tested (say, platinum) is laid across the copper wires at right angles and pressed into contact with them by a weighted pad. By connecting the copper wires to a potentiometer the resulting thermal E.M.F. can be measured. The platinum wire is then moved until another section is in contact with the copper wires and the E.M.F. again measured. If the platinum wire were perfectly homogeneous, the value would be the same as before. By making successive small movements of the platinum wire it can be completely explored for homogeneity and any changes due to contamination detected. The authors describe a simple modification of this apparatus, which has been found to give good results.

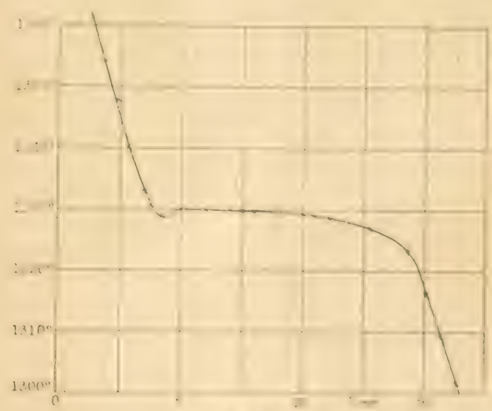

FIG. 2

[illegible]

[illegible] methods to the measurement of [illegible] temperatures.

The rapid development of the [illegible] and the simplicity of the [illegible] the [illegible] industrial work [illegible]

The work of [illegible] has proved [illegible] that the [illegible]

The [illegible]

[illegible]

[illegible]

procedure would imply two conditions. First, that the laws of radiation have an indisputable theoretical foundation, and second, that it is possible so to design an instrument that its scale can be calculated with mathematical certainty from the radiation law. In practice neither of these conditions can be complied with.

The Stefan-Boltzmann law is perhaps the best established, both theoretically and practically, of all laws of "radiation." The experiments of Lummer and Pringsheim over the range of 100°C. to 1,000°C., and the later observations of Mendenhall and Forsythe at 1,100°C. and 1,550°C., have proved conclusively that the law is valid over the entire temperature range covered by the gas thermometer. It may, therefore, be employed with confidence as the basis of methods for the evaluation of high temperatures.

In radiation pyrometry the "black body" occupies much the same rôle as the "perfect gas" in gas thermometry—an ideal which can be closely approximated to in practice, but never fully realised.

The thermo-electric type of radiation pyrometer is sufficiently well known to need no description. Its standardisation is affected by a comparison with a thermo-element over the range 500°C. to 1,400°C., while extrapolation beyond this temperature can be effected on the basis of the formula $e=aT^b$, where e is the E.M.F. and b is constant, nearly 4. Several factors contribute to cause variations in the value of the index from 4.

The E.M.F. generated by the thermocouple is not a linear function of the temperature rise. The rate of heat loss from the junction is not strictly proportional to its temperature excess. Stray reflections from the walls may reach the receiving disc. Consequently the index b has to be determined for each individual instrument.

Calibration.—For the calibration of instruments which are to be employed as working standards electric furnaces are employed.

The apparatus in use at the National Physical Laboratory has been developed by Dr. Harker and Mr. Blackie. A series of four large furnaces are mounted on an iron platform mouth downwards. Each is provided with suitably disposed diaphragms, and the pyrometers are focussed on a plug of refractory material fixed in the centre of the furnace. Across the face of each plug a platinum-platinum-rhodium thermo-element is stretched, so that the mean temperature is obtained with accuracy.

Sources of Error.—While it is possible in the laboratory to reproduce "black body" conditions with considerable accuracy, in the industries it is often impossible to approximate more than roughly to such conditions.

The radiation from muffles and furnaces is generally sufficiently near to full radiation to make the application of any corrections to the pyrometer readings unnecessary, but the radiation from metallic objects departs considerably from the ideal contemplated by the Stefan-Boltzmann law. When the surface is oxidised the difference between the apparent and real temperature will be a function of the [illegible] of the surface.

The total-radiation pyrometer is of very limited use with molten metals, [illegible] can never be freed from haze or fog, and [illegible] the walls of the furnace or crucible reflected at the metal surface is apt to introduce serious errors. It has the advantage over the optical pyrometer inasmuch that it can be made recording.

OPTICAL PYROMETERS.

Of the laws of radiation, those for the representation of the distribution of energy in the spectrum are the least satisfactory theoretically, [illegible] practically. Wien's law

[illegible]

[illegible] It represents with fair accuracy the [illegible] for large values of λ and T [illegible] λT exceeds 3,000. Planck's formula

[illegible]

[illegible] the experimental facts over the entire range [illegible] empirical formula. [illegible]

It [illegible] Planck's equation [illegible] that of Wien's for small values of λT. In practical pyrometry Wien's form is [illegible] on account of its [illegible] logarithmic form.

Practical Types.—The three commonly used types of optical pyrometer are: [illegible] the disappearing-filament type, [illegible] the polarising type, [illegible]

From the point of view of sound theoretical foundation for the design of the instrument, the polarising type is the best, since essentially it is a photometer—in fact, an adaptation of the König spectrophotometer. Consequently the temperature scale can be readily extrapolated to high temperatures on the basis of Wien's or any other radiation law. Further, the scale is independent of the permanency of the electric lamp which is set from time to time against an amyl-acetate lamp.

The disappearing-filament pyrometer is a modified telescope, in which the image of the hot object is focussed in a plane containing the filament of an electric lamp. So it is easy to pick out the object whose temperature is desired, and readings may be obtained to the limits of visibility.

Calibration.—The calibration of optical pyrometers is effected in a manner similar to that described for total-radiation pyrometers, namely, by sighting them on a "black body" furnace the temperature of which is determined by a thermocouple.

The procedure has the advantage of not presupposing perfection of the optical system or a knowledge of the wave-length of the red light transmitted by the filter glass.

The calibration of the polarising type is based on the following theoretical considerations:—If I_1 and I_2 are the intensities of two plane polarised beams of radiation matching at angles ϕ_1 and ϕ_2 a beam of constant intensity, such as that from an electric lamp, when viewed through a nicol prism, then—

$$\frac{I_1}{I_2}=\frac{\tan^2\phi_1}{\tan^2\phi_2}.$$

In optical pyrometry, by the insertion of a suitable red glass in the path of the two beams, it is possible to work with narrow spectral bands and consequently apply Wien's law, according to which the intensity of light of wave-length emitted by a "full radiator" is given by the expression

$$I=\frac{C_1}{\lambda^5}e^{-C_2/\lambda T}.$$

In the case of instruments to be employed as working standards, it is advisable to check the calibration by direct observations of the melting-points of pure materials. A wire of the metal is stretched across the face of a diaphragm in the furnace and the temperature gradually raised.

The melting of the metal is indicated by the breaking of the electrical circuit and the temperature at this instant is noted.

Gold and palladium are very satisfactory for this purpose. Copper requires a reducing atmosphere, and consequently it is necessary to close the front of the furnace with a glass window and make corrections for the absorption of the glass.

For routine work in calibrating optical pyrometers, platinum-wound furnaces with thermocouples may conveniently be used to a temperature of 1,350°C. Above this it becomes necessary to rely on a comparison with a standard optical pyrometer which has itself been calibrated, in terms of the fixed points, to the highest possible limits. Provided that the standard instrument and the one under test are of the same type and use the same wave-length, there is little or no advantage to be gained by having a "black body" as a source of comparison; any hot object of suitable size and sufficiently uniform and constant in temperature will serve as well.

Our experience is that the tungsten arc-lamps described by Gimingham and Mullard and manufactured by the Edison and Swan Electric Co. is very satisfactory for the purpose. The temperature remains constant so long as the energy is not varied, and by running the lamp off a battery and adjusting the energy to particular values, temperatures may be reproduced with very fair accuracy. The range [illegible] very considerable. For example, one lamp which has been [illegible] for over a year may be run from 0·8 to 1·2 amperes, giving temperatures from 1,500°C. to 2,400°C. By the use of absorption glasses the apparent temperature of this lamp may be cut down [illegible], though it is not advisable to continue this process [illegible] the absorption glasses are of exceptional quality, as colour [illegible] difficulties are likely to supervene.

The [illegible] advantage in using a tungsten arc lamp as compared with a "black body" source, such as a carbon tube furnace, consists in the [illegible] certainty of manipulation and the enormous economy of [illegible].

Before these Papers were discussed, Mr. S. A. Mann, of Messrs. Hadfields, demonstrated one of Mr. Brown's automatic temperature control pyrometers. Samples of the instruments referred to in the Paper were on their way from America, but did not arrive in time for the meeting. Messrs. Hadfield, however, were able to exhibit one of the instruments, and it was stated that the results claimed in the Paper had been fully justified in practice.

(*To be continued.*)

MR. C. H. WORDINGHAM'S PRESIDENTIAL ADDRESS TO THE INSTITUTION OF ELECTRICAL ENGINEERS.*

(*Concluded from page 239.*)

It is in labour probably that the most tremendous problem of the immediate future resides. The effects of the war thereon have been manifold, far-reaching and powerful. Neither masters nor men are likely to put up with their relations with one another being interfered with by outside authorities even so exalted as the Government, when once the war is over, and the fate of industry will depend upon how the acutely difficult problems are faced and dealt with by the two parties concerned.

The extraordinary development of women's labour raises issues that are intricate and new. Having tasted independence and high wages, a number of those now working will desire to continue their present activities, and probably this will be bitterly opposed by the men, but I do not believe that there will be any great access of women permanently to the ranks of engineering workers.

These new elements superimposed on the old in connection with labour problems render those problems more difficult of solution. Before the war the attitude of labour to capital and the community at large on many occasions seemed unreasonable, rapacious and unpatriotic. But, little as we may like to admit it, there have been many reprehensible actions on the part of the employers and the men's attitude has not always been without strong provocation. No one can listen to the speeches of some of the labour leaders and be acquainted with their personalities without recognising the marked ability and honesty of purpose of many of them.

The question of labour is too vast and too complicated to enter into here, but it is quite certain that the men will have to be given a much greater share in the management and profits of the undertakings they are engaged on. It is equally certain that they are not at present fit to occupy the position that the importance of their contribution to the country's wealth justifies. They must be taught that they have duties as well as rights; they must be educated to take an intelligent interest in their work and in its development; their prejudices, ignorance, and suspicion must be broken down and many serious misconceptions cleared away. Masters must learn that they themsleves must do what they enjoin on their men; they must remove their open ignorance of the conditions of life and of the viewpoint of their men, and they must get rid of the suspicion that they entertain of the men which is just as great and perhaps as ill founded as the men's suspicion of them. While asking the men to deal fairly with them they must see to it that they set the example of fairness.

I believe success is to be attained by giving each man in some way or another a direct interest in the financial results of the concern employing him; by letting him have some say in its management; by treating him as a man and not as a machine; by letting individuality have play; by ensuring that every man even though not brilliant shall if he works steadily be decently housed, clothed and fed; by shielding men from coercion by their fellows, tending to reduce their efficiency; and by promoting in every way mutual regard and trust between employer and employed. No doubt the attainment of these objects will radically alter the conditions to which we have grown accustomed, but in any case they will be changed and it is for this generation to see that they are ameliorated so far as the nation as a whole is concerned and not turned into chaos and ruin.

Perhaps the most potent influence in directing the imminent changes into the proper channel, as well as in [illegible] competition with other nations, is education. Let us continue in every way in our power the pursuit of [illegible] research and let us endeavour to imbue every human being with an appreciation of its importance and give to him a knowledge of the principles of science, but let us while giving to science the high position that is its due, keep it in its proper place, and not assume that it can be a substitute for those moral and religious principles which alone can afford adequate or worthy motives for human action or give courage to fight and perseverance, and [illegible].

Engineering and scientific training are absolutely essential for an industrial nation, but it must never be forgotten that they provide but the tools which must be as perfect of their kind as they can be and without which no work can be done, but it is the [illegible] and moral qualities of the nation which will decide the issue in the world competition.

POWER SUPPLY.

It is obvious that if we were starting now with our present knowledge we should not provide electrical energy for such a comparatively small area as England or even Great Britain from hundreds of independent stations. But we are not starting now. We cannot ignore what has gone before. Any scheme which is brought forward cannot, in common justice, ignore the claims of those who are now carrying on the business which they have built up by their capital, by their work and by their skill. Due provision must be made for the gradual wiping off of the existing capital, and adequate compensation must be given to those displaced whose lives have been devoted to what they had every right to expect would be a lifelong business.

The objects in view will be best attained by developing what is good in existing systems and eliminating what is bad, rather than by attempting to supersede all that has been done suddenly and abruptly. There are a number of existing stations in which the generating units are large and well-nigh as efficient as any that can be devised at the present day and which are well situated for economical working. Let these be linked up to adjacent stations and let them be worked to their utmost, in some instances being extended, and let the smaller gradually be eliminated, the worst being shut down at once and the others worked in such a way as to contribute what they can efficiently to the general supply until the cost of their plant is wiped out. I would remind you that it may quite possibly be more economical to work inefficient plant already in existence to provide stand-by supply than to purchase new and more efficient plant for the purpose. Side by side with this development let new stations on ideal lines be erected to supplement the old, which in due course they will supplant.

ECONOMY OF FUEL.

Closely connected with the problem of power supply is that of national economy of fuel. There is a tendency to confuse economy of fuel with cheap power supply, but the two are quite distinct though closely connected. I venture to think that, in regard to these matters, electrical engineers have been apt to arrogate to themselves too prominent a position. It is little short of ludicrous to ignore the great gas industry either in respect of their consumption of coal or of the experience of their engineers and managers. While for motive power and lighting and for certain kinds of furnace work, electrical operation is pre-eminent and will almost certainly in the fullness of time be universal, there will still be an immense field for heating by gas. Apart from this, however, I hold most strongly that gas production will be an intermediary between the raw fuel and the live steam and so be concerned in the generation of the whole of the electrical energy used. The whole of the coal raised should be treated as near the pit as practicable for the extraction of those substances usually referred to by the generic name of by-products and for the production of a fuel, whether solid, liquid or gaseous, or one or more combined, which can be conveniently used for the direct production of steam. [illegible] take the matter in hand and produce his steam and conduct the other operations necessary to provide the electrical energy for transmission at high pressure to the distributing centres.

The only way in which the interests of fuel-economy and efficient distribution can be [illegible]

[illegible]

cated, or possibly by liquid fuel, will probably be introduced on the grounds of cheapness and economy though certainly not of comfort or health.

ELECTRICAL ENGINEERS.

There is a tendency at the present time to regard manufacturing as synonymous with electrical engineering and to disregard the other branches of the latter, more especially to belittle the consulting engineer, many going so far as to say that he will shortly disappear. While recognising to the full the importance of the position of manufacturers and the shortcomings of many of those calling themselves consultants, I think it would be a distinct loss to the profession were the consulting engineer to be eliminated and his work taken over by the manufacturer. The lopping off of a branch corresponding to the highest positions in civil engineering and in other professions, such as the medical, would be greatly to be deplored, as it would mean the narrowing down of a profession which now embraces every branch of an engineer's work. Apart from this, there would be a distinct loss to the industry. From the manufacturer's point of view, it is clearly advantageous to have someone who can state the purchaser's requirements in a definite manner in terms that can be understood without ambiguity, so that all tenders are on an equal footing, and who is able to appreciate the relative values of the offers firms make irrespective of the persuasive powers of their representatives. From the purchaser's standpoint, the consultant necessarily takes a broader view, and his advice is likely to be more reliable, than that of any individual firm of manufacturers who, however honest in intention, must necessarily be biased in favour of their own methods of attacking a problem and who will be tied largely to their own designs which may not be uniformly the best. In my experience, also, the consultant is often able materially to assist manufacturers by putting before them the needs of users that they would never have thought of, and by defining precisely the conditions to be fulfilled in a manner that the user never could on account of his not possessing the necessary technical knowledge to enable him to do so.

I venture to think that all parties would benefit by a stricter etiquette than now exists. Manufacturers should support the consultant in the same way that the general practitioner does the Harley-street specialist or the solicitor the King's Counsel, instead of providing advice gratis and ousting the consultant. On the other hand, the consultant (as all the leading men do) should confine himself strictly to occupying an advisory position without interest, however remote, in any manufacturing concern and abstain from indulging in his own fads, a practice that has greatly irritated manufacturers and contributed largely to the present situation.

A reform greatly needed in connection with engineering concerns is the appointment of men of high technical qualifications instead of clerks to position of manager or secretary. It is monstrous that engineers should undergo a lengthy and arduous training, provide the skill, inventiveness and high qualities necessary for the efficient management of men, to find themselves in receipt of rewards only a fraction of those bestowed on an individual whose attainments are purely clerical and who has it in his power to mar their efforts and to whom they must to a large extent be subservient. An engineering undertaking should be managed by an engineer; engineers have the power to ensure this entirely in their own hands; they are absolutely indispensable and if properly organised can secure their proper position in commercial undertakings.

It is a matter for surprise that engineers should count for so little in the public eye. Partly engineers themselves are to blame for this. They have, as I have said, let others occupy the prominent positions that are theirs by right, those positions which bring them most into contact with their non-engineering fellow men.

There is no reason to suppose that engineering will become of less importance in warfare, nor, alas! that warfare will cease to have to be provided for. We ought, therefore, to start and maintain an organisation that shall ensure that the technically trained material in the country shall be applied with maximum effect immediately war breaks out, and avoid the lamentable waste that has occurred in the present war by disregarding the technical qualifications of men, and by giving others technical work for which their training has been unsuited. Not only should all individual engineers be classified according to a well thought out scheme, but actual posts in [illegible] should be assigned to them. I would regard each [illegible] of Government staff as a sort of nucleus crew and make definite appointments to come into force on the outbreak of war, with adequate reserves to draw upon, so that every staff could expand [illegible] the [illegible] of extra work came on it, and I would give these reserve men an insight into official methods so that their technical knowledge might be instantly utilisable. In [illegible] cases whole departments could have to be created in war time [illegible]. [illegible] I would have a definite period [illegible] be a gradual change of men during peace as time went by, so that the organisation might be kept up to date and men in the prime of life and of proved attainments be ready at the nation's call. Similarly all factories should be organised so that each would in war time contribute a definite product in definite quantities when the war need arose.

A word as to engineering as a profession; it surely, rightly apprehended, is one of the most ennobling. It requires an active brain, making, as it does, a direct appeal to the intellect, and it brings a man into intimate contact with the laws and processes of Nature and their everlasting truths, while constructive work is the nearest approach to creation possible to a created being. I would particularly impress on the young engineer the need for thoroughness in all he does—"Whatsoever thy hand findeth to do, do it with thy might" is a maxim applying with peculiar force to engineering. Strive after perfection and do not regard the smallest job as unworthy of your best efforts. Let love of your work for the work's sake be your dominant motive and do not aim lower than perfection even though absolute perfection may be unobtainable; believe me the more material benefits will be added to you.

THE LARGEST GRAPHIC METER IN THE WORLD.*

What is stated to be the largest graphic recording meter in the world, has been designed and built for the Keokuk hyro-electric plant of the Mississippi River Power Co., which has an equipment of 15 generators, each rated at 7,500 kw.; the ultimate capacity of the plant may comprise 30 such generators.

The meter is intended to give a graphic record of the output of the plant, whether operated in sections or as a single system. A special type of curve-drawing instrument was therefore required greatly beyond the capacity of anything previously attempted in this direction. The specifications required a high degree of accuracy, freedom from appreciable errors on varying voltage, frequency, power factor and temperature, with a degree of damping which would prevent overshooting.

The instrument is designed (1) to enable the operator to have the proper number of generators on the line for the load to be carried; (2) to make an accurate record of the output of the plant, giving information relative to growth of business, load factor, variation of load with seasons of the year, days of the week, and hours of the day, relative night and day output, peaks, periods of low load, &c.; and (3) to obtain a record of the frequencies and duration of station and line troubles and the performance of the plant under such conditions.

To measure the output of 30 three-phase generators required the use of 30 polyphase meter elements, each made up of two single-phase units. The desirability of using the same design in other instruments was borne in mind, the supporting frame being made up of three superimposed sections, each carrying 10 meter-elements. This makes it possible to construct a similar instrument of 10 elements or any multiple of 10 to 50. The instrument is self-contained, without the use of any external case, so that any individual meter-element may be removed and calibrated without putting the instrument out of operation.

The moving appliance consists of six aluminium vanes all mounted on a single staff and designed to eliminate friction. All connections are carried to the top of the instrument to a circular terminal board carrying 240 binding posts, four being used for each single-phase element. The actual width of the chart is $12\frac{1}{2}$ in. The charts are printed in 12-hour sections, fed at the rate of 3 in. per hour. The indicating scale, which faces the operator's desk, is illuminated and graduated to the same range as the chart.

With such an instrument it is possible to totalise the output of a station of any capacity or a number of stations or systems regardless of difference in frequency or voltage and whether they are in synchronism or not.

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, on receipt of published price, plus postage.]

Mineral Industry: Its Statistics, Technology and Trade During 1916, edited by G. A. Roush. Vol. XXV. (London: Hill Publishing Co.) Pp. xx + 939. 42s.

"Sir Charles W. Macara, Bart.: A Sketch of Modern Lancashire," by W. Haslam Mills. (Manchester: Sherratt & Hughes.) Pp. 334. 6s. net.

Heat Drop Tables: H.P. Gauge Pressures: L.P. Absolute Pressures. By H. Moss, M.Sc., and Prof. H. L. Callendar, M.A. (London: Edward Arnold.) Pp. 63. 5s. net.

* Abstract of an article in the "Electrical Review and Western Electrician."

ON THE EFFECT OF ARMATURE RESISTANCE AND REACTANCE ON THE TERMINAL PRESSURES OF A ROTARY CONVERTER.

BY S. NEVILLE, B.SC., D.I.C.

1. INTRODUCTION.

In the design of a rotary converter—especially with reference to the calculation of pressure regulation and compounding—there may arise some difficulty in estimating the influence of the resistance and true reactance of the armature winding upon the relationship between the induced pressure and the P.D. at the commutator and slip-rings under load conditions. Thus, assuming the transformation of energy to be from alternating to continuous current, the machine may be mentally regarded as being driven by alternating currents as in the case of a synchronous motor, and at the same time delivering a continuous current in the manner of a mechanically-driven continuous-current generator. Then it is apparent that if only the alternating currents were present the terminal pressure applied at the slip-rings would *exceed* the induced pressure between the same two points by the amount of the resistance and reactance drop in the winding due to the alternating currents driving the machine; while, on the other hand, if only the continuous current were present the terminal pressure at the brushes would be *lower* than the induced pressure by the amount of the resistance-drop produced by the continuous-current output. Hence, where—as in the actual machine—the two currents exist simultaneously, and the slip-rings and commutator are connected to one and the same winding, it becomes necessary to consider the resultant effect of the superposition of the two currents.

It will be shown that, owing to the movement of the slip-ring tappings relatively to the brushes, all the terminal pressures are of a somewhat irregular pulsatory nature; but that there is also an important action of mutual neutralisation between the two currents in their effects upon the useful values of the terminal pressures, that is, upon the mean pressure at the commutator or upon the fundamental pressures at the slip-rings. It will be obvious that the actual extent of this neutralisation depends essentially upon the ratio between the magnitudes of the two currents and also upon the power factor at which the machine is working.

2. METHOD AND SIMPLIFICATIONS.

The method to be now adopted consists in deducing in the first place two Fourier series—(a) representing the space or peripheral distribution of current in the armature due solely to the alternating currents supplied to the machine, and (b) representing the corresponding distribution in the winding of the continuous current output. [illegible] at any point on the periphery upon which the resistance drop depends is then simply the sum of these two series, and the total resistance drop between any two points on the periphery is therefore proportional to the [illegible] between the two points [illegible] the expression so obtained [illegible] it is possible to deduce [illegible] resistance drop at any pair of [illegible] practical importance.

In considering the effect of the [illegible] of the winding [illegible] [illegible]

[illegible]

currents, and the value of this ratio for a rotary converter working at a given power factor and efficiency will then be introduced. Further, by reversing the sign of one of the currents, the results can be made applicable to the case of a "double-current generator," a mechanically-driven machine delivering both continuous and alternating currents.

No attempt will be made to investigate the small ripple of very high frequency which arises in practice from there being a finite number of coils and commutator bars, and also the small effect of the commutator and the alternating-current tappings being actually at opposite ends of the armature will be neglected. These approximations enable the problem to be much simplified, for it may then be considered that the number of commutator bars is made infinitely great and that the winding consists of an infinite number of very short conductors. The whole armature may then be imagined to be replaced by a single endless wire upon which the brushes slide, and to which the fixed alternating-current tappings are made at suitable regular intervals.

Fig. 1 shows this simplified arrangement at the instant of time when one of the tappings—which point will throughout be taken as the origin for all angular measurements—has moved through an angle θ from one of the continuous-current brushes, the direction of motion being from left to right. Then the distance between successive brushes represents an angle π,

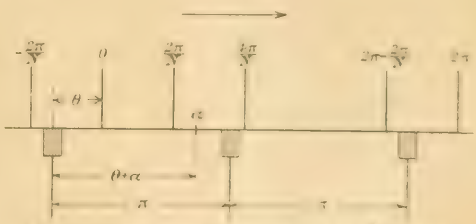

FIG. 1.—DIAGRAMMATIC REPRESENTATION OF ARMATURE.

and, if N be the number of phases (here defined as the number of equidistant tappings irrespectively of any specific mode of external loading), the angular distance between successive tappings is obviously $2\pi/N$.

3. INDUCED PRESSURES.

In order to deduce the phase relationships of the alternating currents in the various parts of the winding, it is necessary in the first place to derive an expression for the total induced E.M.F. in the various phases of the winding—[illegible]

[illegible]

$$[illegible] \quad (1)$$

Similarly, between successive pairs of tappings the induced pressures are

$$\left.\begin{aligned} e_2 &= 2\hat e\sin\left(\theta-3\frac{\pi}{N}\right)\sin\frac{\pi}{N} \\ e_3 &= 2\hat e\sin\left(\theta-5\frac{\pi}{N}\right)\sin\frac{\pi}{N} \\ &\quad\cdots\cdots\cdots \\ e_N &= 2\hat e\sin\left(\theta-\overline{2N-1}\frac{\pi}{N}\right)\sin\frac{\pi}{N} \end{aligned}\right\} \quad \dots \quad (1)$$

4. DISTRIBUTION OF ALTERNATING CURRENT.

Assuming, now, that the load taken from the alternating current mains is balanced, the currents in all the phases of the winding will reach the same maximum value $\hat i$, and the current in each part will lag behind the total induced pressure in that phase by the same angle φ, where $\cos\varphi$ is the power factor at which the machine is working. Hence, considering only the fundamental waves, for the harmonics in the current are usually small, the currents in the armature between the successive pairs of tappings will be

$$\left.\begin{aligned} i_1 &= -\hat i\sin\left(\theta-\varphi-\frac{\pi}{N}\right) \\ i_2 &= -\hat i\sin\left(\theta-\varphi-3\frac{\pi}{N}\right) \\ i_3 &= -\hat i\sin\left(\theta-\varphi-5\frac{\pi}{N}\right) \\ &\quad\cdots\cdots\cdots \\ i_N &= -\hat i\sin\left(\theta-\varphi-\overline{2N-1}\frac{\pi}{N}\right) \end{aligned}\right\} \quad \dots \quad (2)$$

where the negative sign is used to indicate that the alternating currents convey energy *to* the machine.

Now, at any instant the alternating current is constant between each pair of tappings, so that a curve representing its peripheral distribution would consist of a number of rectangular steps; thus, if i_a denotes the current at any point a at the instant of time considered, the current distribution is given by

$$\left.\begin{aligned} i_a &= -\hat i\sin\left(\theta-\varphi-\frac{\pi}{N}\right)\text{ from } a=0 \text{ to } a=\frac{2\pi}{N} \\ &= -\hat i\sin\left(\theta-\varphi-3\frac{\pi}{N}\right)\text{ from } a=\frac{2\pi}{N}\text{ to } a=\frac{4\pi}{N} \\ &= -\hat i\sin\left(\theta-\varphi-5\frac{\pi}{N}\right)\text{ from } a=\frac{4\pi}{N}\text{ to } a=\frac{6\pi}{N} \\ &\quad\cdots\cdots\cdots \\ &= -\hat i\sin\left(\theta-\varphi-\overline{2N-1}\frac{\pi}{N}\right)\text{ from } a=2\pi-\frac{2\pi}{N}\text{ to } a=2\pi \end{aligned}\right\} \quad (3)$$

For greater convenience the distribution may be resolved into a number of harmonic components constituting a Fourier series of the form:

$$i_a = \sum_1^\infty A_n\cos na + \sum_1^\infty B_n\sin na,$$

in which the various terms are readily found to be respectively as follows:—

$$A_0 = \frac{1}{2\pi}\int_0^{2\pi} i_a\,da$$

$$= -\frac{\hat i}{2\pi}\left[\sin\left(\theta-\varphi-\frac{\pi}{N}\right)a\Big|_0^{2\pi/N} + \sin\left(\theta-\varphi-3\frac{\pi}{N}\right)a\Big|_{2\pi/N}^{4\pi/N} + \dots\text{ to } N \text{ terms}\right]$$

$$= -\frac{\hat i}{2\pi}\cdot\frac{2\pi}{N}\left[\sin\left(\theta-\varphi-\frac{\pi}{N}\right)+\sin\left(\theta-\varphi-3\frac{\pi}{N}\right) + \dots\text{ to } N\text{ terms}\right]$$

$$= -\frac{\hat i}{N}\sin(\theta-\varphi-\pi)\frac{\sin\frac{N}{2}\cdot\frac{2\pi}{N}}{\sin\frac{1}{2}\cdot\frac{2\pi}{N}} = 0 \text{ since } N \neq 1; \quad \dots \quad (4)$$

$$A_n = \frac{1}{\pi}\int_0^{2\pi} i_a\cdot\cos na\cdot da.$$

$$= -\frac{\hat i}{\pi n}\Big[\sin\left(\theta-\varphi-\frac{\pi}{N}\right)[\sin na]_0^{2\pi/N} - \sin\left(\theta-\varphi+3\frac{\pi}{N}\right)$$
$$[\sin na]_{2\pi/N}^{4\pi/N} - \sin\left(\theta-\varphi-5\frac{\pi}{N}\right)[\sin na]_{4\pi/N}^{6\pi/N} - \dots\text{ to } N\text{ terms}\Big]$$

$$= -\frac{\hat i}{\pi n}\sin n\frac{\pi}{N}\Big[2\sin\left(\theta-\varphi-\frac{\pi}{N}\right)\cos n\frac{\pi}{N} + 2\sin\left(\theta-\varphi-3\frac{\pi}{N}\right)$$
$$\cos 3n\frac{\pi}{N} + 2\sin\left(\theta-\varphi-5\frac{\pi}{N}\right)\cos 5n\frac{\pi}{N} + \dots\text{ to } N\text{ terms}\Big]$$

$$= -\frac{\hat i}{\pi n}\sin n\frac{\pi}{N}\Big[\sin\left(\overline{n-1}\frac{\pi}{N}+\theta-\varphi\right) - \sin\left(\overline{n+1}\frac{\pi}{N}-\theta+\varphi\right)$$
$$+\sin\left(3\,\overline{n-1}\frac{\pi}{N}+\theta-\varphi\right) - \sin\left(3\,\overline{n+1}\frac{\pi}{N}-\theta+\varphi\right)$$
$$+\sin\left(5\,\overline{n-1}\frac{\pi}{N}+\theta-\varphi\right) - \sin\left(5\,\overline{n+1}\frac{\pi}{N}-\theta+\varphi\right)$$
$$+ \dots \text{ to } N\text{ terms}\Big]$$

$$= -\frac{\hat i}{\pi n}\sin n\frac{\pi}{N}\Big[\sin\left(N\,\overline{n+1}\frac{\pi}{N}+\theta-\varphi\right)\frac{\sin N\,\overline{n+1}\frac{\pi}{N}}{\sin\overline{n+1}\frac{\pi}{N}}$$
$$-\sin\left(N\,\overline{n-1}\frac{\pi}{N}-\theta-\varphi\right)\frac{\sin N\,\overline{n-1}\frac{\pi}{N}}{\sin\overline{n-1}\frac{\pi}{N}}\Big]; \quad (4a)$$

and in a very similar manner it will be found that

$$B_n = +\frac{\hat i}{\pi n}\sin n\frac{\pi}{N}\Big[\cos\left(N\,\overline{n+1}\frac{\pi}{N}-\theta-\varphi\right)\frac{\sin N\,\overline{n+1}\frac{\pi}{N}}{\sin\overline{n+1}\frac{\pi}{N}}$$
$$-\cos\left(N\,\overline{n-1}\frac{\pi}{N}-\theta-\varphi\right)\frac{\sin N\,\overline{n-1}\frac{\pi}{N}}{\sin\overline{n-1}\frac{\pi}{N}}\Big]. \quad (4b)$$

The constant term A_0 being zero indicates that for any instant of time and for all numbers of phases the curve of current distribution has the same area on both sides of the base line.* The expressions for the coefficients A_n and B_n will be at once seen to be very similar in form, and admit of much simplification in consequence of certain necessary relationships between n and N without which the coefficients vanish.

Thus, in the numerator of the fractional part of both expressions,

$$\sin N\,\overline{n+1}\frac{\pi}{N} = 0, \text{ and } \sin N\,\overline{n-1}\frac{\pi}{N} = 0,$$

for all integral values of n; hence both expressions vanish except when *either* of the denominators

$$\sin\overline{n+1}\frac{\pi}{N} = 0, \text{ or } \sin\overline{n-1}\frac{\pi}{N} = 0;$$

which condition is only fulfilled when either $(n+1)/N$ or $(n-1)/N$ is an integer or zero; that is, when either $n+1 = KN$, or $n-1 = K'N$, K and K' being positive integers, and K' being also possibly zero.

Now when $n+1 = KN$, the *first* term in each expression assumes the form 0/0, which in this case has the value

$$\text{Lt.}\left(\frac{\sin N\,\overline{n+1}\frac{\pi}{N}}{\sin\overline{n+1}\frac{\pi}{N}}\right) = \text{Lt.}\left(\frac{\sin NK\pi}{\sin K\pi}\right);$$

* This conclusion might have been otherwise deduced from the fact that each of the steps of the figure is of the same length and has its middle point on a simple sinusoidal curve (as is shown by the original expression for the current distribution), for the area under each step then bears a constant ratio to the area under the sinusoidal wave between the same pair of ordinates.

and when $n-1=K'N$, the *second* term in each expression assumes the form 0/0, now having the value

$$\text{Lt.}\left(\frac{\sin N\,.\,\overline{n-1}\,.\,\frac{\pi}{N}}{\sin \overline{n-1}\,.\,\frac{\pi}{N}}\right)=\text{Lt.}\left(\frac{\sin NK'\pi}{\sin K'\pi}\right).$$

The value of these limits is obviously always N, but its sign varies according as K or K' is even or odd; thus, in either case, when K or K' is *even*, the limit is $+N$: when K or K' is *odd*, the limit is $+N$ if N is *odd*, and is $-N$ if N is *even*. Hence the value of the limit may always be written—

$$N(-1)^{(N-1)K}, \text{ or } N(-1)^{(N-1)K'},$$

as the case may be.

Now, except when $N=2$, which case will be dealt with later, it is manifestly impossible for any value of n to fulfil both the conditions $n+1=KN$ and $n-1=K'N$ simultaneously; so that *one* term in each of the expressions for the Fourier coefficients always vanishes.

Hence, these expressions reduce to

$$\left.\begin{aligned}A_n&=-\frac{I}{n\pi}\sin n\frac{\pi}{N}\,.\,N(-1)^{(N-1)K}\sin(KN\pi+\theta-\varphi)\\&\qquad\text{when } n+1=KN\\&\quad+\frac{I}{n\pi}\sin n\frac{\pi}{N}\,.\,N(-1)^{(N-1)K'}\sin(K'N\pi-\theta-\varphi)\\&\qquad\text{when } n-1=K'N\end{aligned}\right\}\quad . \quad . \quad (5)$$

and

$$\left.\begin{aligned}B_n&=-\frac{I}{n\pi}\sin n\frac{\pi}{N}\,.\,N(-1)^{(N-1)K}\cos(KN\pi+\theta-\varphi)\\&\qquad\text{when } n+1=KN\\&\quad-\frac{I}{n\pi}\sin n\frac{\pi}{N}\,.\,N(-1)^{(N-1)K'}\cos(K'N\pi-\theta-\varphi)\\&\qquad\text{when } n-1=K'N\end{aligned}\right\}\quad . \quad . \quad (5a)$$

But $\sin(KN\pi+\theta-\varphi)=(-1)^{KN}\sin(\theta-\varphi)$,

and $\cos(KN\pi+\theta-\varphi)=(-1)^{KN}\cos(\theta-\varphi)$.

Further

$$\sin n\frac{\pi}{N}=\sin(KN-1)\frac{\pi}{N}=\sin\left(K\pi-\frac{\pi}{N}\right)=-(-1)^{K}\sin\frac{\pi}{N},$$

or

$$\sin(K'N+1)\frac{\pi}{N}=\sin\left(K'\pi+\frac{\pi}{N}\right)=(-1)^{K'}\sin\frac{\pi}{N}.$$

Inserting these simplifications, the expressions for the coefficients further reduce to

$$\left.\begin{aligned}A_n&=\frac{I}{\pi n}\sin\frac{\pi}{N}\,.\,N\sin(\theta-\varphi),\text{ when } n+1=KN\\&=\frac{I}{n\pi}\sin\frac{\pi}{N}\,.\,N\sin(\theta-\varphi),\text{ when } n-1=K'N\end{aligned}\right\}\quad . \quad (6)$$

and $B_n=\mp\frac{I}{n\pi}\sin\frac{\pi}{N}\,.\,N\cos(\theta-\varphi)$ [illegible] (6a)

both when $n+1=KN$ and when $n-1=K'N$.

Considering now the particular case of $N=2$, it will be seen that if $n+1=KN$, then also $n-1=KN-2=K'N$, where $K'=K-1$; consequently *both* conditions are always fulfilled simultaneously, and *both* terms in the original expressions (4) and (4a) assume the indeterminate form already considered. Moreover, it will be noticed that when K is odd K' is even, and vice versa, so that the limit [illegible] second term [illegible] the opposite sign [illegible] and both of the two terms [illegible] [illegible] than that given by the above expressions (6) and (6a). [illegible] all possible values [illegible] K and K' [illegible] half of the result [illegible]. That is to say, the expressions (6) and (6a) [illegible] in that case without modification, [illegible] between K and K' [illegible]

$$[illegible]\ \frac{I}{n\pi}\sin\frac{\pi}{N}\,.\,N\sin(\theta-\varphi)\ [illegible]\ n+1=KN\quad (7)$$

$$B_n=\mp\frac{I}{n\pi}\sin\frac{\pi}{N}\,.\,N\cos(\theta-\varphi),\text{ when } n\pm1=KN\quad . \quad . \quad (7a)$$

and the Fourier series becomes

$$i_a=\frac{I}{\pi}N\sin\frac{\pi}{N}\left[\sum^{A}\frac{1}{n}\sin(\theta-\varphi)\cos n\alpha\right.$$
$$\left.\mp\sum^{A}\frac{1}{n}\cos(\theta-\varphi)\sin n\alpha\right],\quad (8)$$

where the letter A affixed to the series, as also in the rest of the Paper, indicates that only those values of n are to be inserted which fulfil one of the conditions $n\pm1=KN$, and where the alternative signs refer to these two conditions respectively.

5. DISTRIBUTION OF CONTINUOUS CURRENT.

If I denote the value of the current entering at a brush, the continuous current in one branch of the armature is clearly $I/2$ and is constant between successive brushes. Since this current is to represent an *output* of power, its value I_a at the general point α must be denoted as follows:—

$$I_a=+I/2 \text{ from } \alpha=-\theta \text{ to } \alpha=\pi-\theta,$$

and $I_a=-I/2$ from $\alpha=\pi-\theta$ to $\alpha=2\pi-\theta$.

Again expressing this peripheral distribution by a Fourier series, the coefficients obtained are

$$A_0=\frac{1}{2\pi}\int_0^{2\pi}I_a\,.\,d\alpha=\frac{1}{2\pi}\,.\,\frac{I}{2}\left\{[\alpha]_{-\theta}^{\pi-\theta}-[\alpha]_{\pi-\theta}^{2\pi-\theta}\right\}=0.\quad . \quad . \quad (9)$$

$$A_n=\frac{1}{\pi}\int_0^{2\pi}I_a\,.\,\cos n\alpha\,.\,d\alpha.$$
$$=\frac{I}{2\pi n}\left([\sin n\alpha]_{-\theta}^{\pi-\theta}-[\sin n\alpha]_{\pi-\theta}^{2\pi-\theta}\right)=\frac{I}{\pi n}\ [illegible]$$
$$=0,\text{ if } n\text{ is even};\quad=\frac{2I}{\pi n}\sin n\theta,\text{ if } n\text{ is odd},\quad [illegible]$$

and similarly

$$B_n=0,\text{ if } n\text{ is even},\quad=\frac{2I}{\pi n}\cos n\theta,\text{ if } n\text{ is odd}.\quad [illegible]$$

Hence, the Fourier series for the continuous-current distribution is

$$I_a=\frac{2}{\pi}I\left[\sum^{B}\frac{1}{n}\sin n\theta\,.\,\cos n\alpha+\sum^{B}\frac{1}{n}\cos n\theta\,.\,\sin n\alpha\right]\quad [illegible]$$

where the letter B affixed to the series, as also in the rest of the Paper, denotes that all positive odd values of n are to be inserted.

6. RATE OF CHANGE OF CURRENT.

Since, as has been already pointed out, the reversal of the continuous current does not result in a reactance [illegible] in the winding apart from the coil undergoing commutation, in deducing the reactance drop in the winding the rate of change of the total current is to be taken as identical with the rate of change of the alternating-current component only. Then, the time-rate of change of the current at any point is given by

$$[illegible]$$

where ω [illegible] is the angular velocity of the machine. Hence

$$[illegible]$$

[illegible] (13)

[illegible]

(To be continued.)

GAS-FIRING BOILERS.*

BY T. M. HUNTER, M.A., B.SC.

The theory of the combustion of gas is simple; but to know what is the best combustion arrangement for any particular set of conditions, and, when this is fitted, to be able to run it so as to get the best results, are matters requiring much study and experience. Most engineers have not access to the formulæ and tables which would enable them easily to test the results they are getting at their gas-fired boilers, so the author has included in this Paper a number of tables which he hopes may be of service.

Early experience with gas-fired boilers was unsuccessful, and many engineers came to the conclusion that they would have to give up boiler firing with by-product producer gas as commercially impracticable, and they turned their eyes to gas engines to utilise the gas economically. Now, however, there is no doubt that gas-fired boilers have now a greater future than ever. Probably the time is not so far distant when our present method of burning coal together with its valuable by-products will be considered obsolete, and possibly even illegal. It will then be replaced by some type of by-product producer or coal distillation plant yielding gas, and this gas will without doubt be largely used for boiler-firing purposes.

In almost every case where gas is burned for practical purposes, the water vapour arising from the combustion escapes to the chimney as a vapour and is not condensed. It has therefore become the custom to treat the latent heat lost through the non-condensation of this water vapour, not as a charge against the boiler, but as a charge against the gas itself. The "net calorific value" of a gas, which is the value generally quoted—is the gross calorific value, less the latent heat of the water vapour of combustion. In all the calculations given in this Paper the net calorific value of the gas is the value used.

After referring to coke oven gas and blast furnace gas, the author passes on to producer gas. Very few people at present use producer gas for boiler firing. The fallacy of a producer gas proposal for boiler firing without absolute security of the results obtained in the boilers is evident if the following figures are taken into consideration. A modern producer will yield nearly 75 per cent. of the heat contained in the fuel as heat in the gas, and with the old combustion arrangements hitherto in vogue no higher efficiency than 50 per cent. can be counted on, so that only 37½ per cent. of the heat in the fuel appears as heat in the steam. With modern combustion arrangements an efficiency of 50 per cent. with producer gas can be raised to 75 per cent., so that fuel of 12,000 therms will give 7 lb. of steam per lb. of fuel; and as with the latest by-product recovery producers the steam necessary for producing by-products has been reduced to the amount necessary to drive the blowers, &c., the actual yield would be over 6½ lb. of steam per lb. of fuel. The result in steam for outside purposes is not materially worse than if the fuel had been burnt in the boilers, and the by-products are available to provide for depreciation, interest and profit.

SUITABILITY OF GAS FOR BOILER FIRING.

Coke-oven Gas.—Coke-oven gas gives comparatively higher efficiencies than the two other kinds of gas in gas-fired boilers owing to the greater ease with which it can be burned. The nature of the gas, however, renders it difficult to make burners which will deal with large quantities of gas. The comparatively narrow flues of Lancashire boilers offer so much resistance to a speedy expansion of the burning gas that unless we use forced draught the evaporation from coke-oven gas in Lancashire boilers is confined to 5,000 lb. to 6,000 lb. per hour. If, therefore, new boilers are contemplated it will always be advisable, provided that the quality of the water permits it, to choose water-tube boilers. Coke-oven gas is particularly suitable for firing water-tube boilers, and with suitable combustion arrangements an evaporation of 5½ lb. per square foot of heating surface per hour could be obtained at the highest efficiency.

Blast-furnace and Producer Gas.—Blast-furnace and producer gas, though of comparatively low calorific value, provided that they are clean and supplied under suitable pressure, will give good results, both in Lancashire boilers and in water-tube boilers. With Lancashire boilers an evaporation of over 8,000 lb. per hour can be obtained, and with water-tube boilers 4 lb. to 5½ lb. per square foot of heating surface.

Blast-furnace gas we have to accept as it comes from the furnace. It is [illegible] that the [illegible] made should be exactly what is [illegible] of gas produced is never likely to be a matter of [illegible] to the blast-furnace manager. We must accept the [illegible] gas is hardly controllable at all, and we [illegible] to deal [illegible] with this condition.

The matter is different in dealing with producer gas. Gas is here a valuable product, though only the second product in point of value. The manager of the producer has it in his power to give us a gas which is much more or much less suitable for boiler firing. We naturally wish the richest possible gas, as it is the easiest gas to burn. At one large Mond plant the gas was found to be just under 100 therms per cubic foot, while at many plants the gas is over 150 therms per cubic foot.

The difference between gross and net calorific value varies with the composition of the gas, being greater as the content of H_2 or CH_4 increases. Thus a gas is more valuable for boiler firing (or for combustion in any way) which has a greater proportion of CO to H_2, other things being equal. Producer buyers should look carefully into this point when specifying new plant. A certain amount of steam must be blown into the producer in order to recover the ammonia, but at present far more is used than the amount necessary for this purpose in order to cool the fire. The author believes that some other method should be adopted for this cooling. The Moore producer, mentioned above, does part of this cooling by means of a water jacket. It has been suggested that much of this cooling could be done by some method such as by blowing in boiler flue gases carrying, say, 15 per cent. of CO_2, and taking advantage of the absorption of heat which occurs when CO_2 is reduced to CO in the presence of heated carbon. This is known in America as the Eldred process. In this way the gas should be improved and much steam saved. The question, however, is still in the region of experiment.

DRYING AND CLEANING GAS.

It is very important that the gas should be dry when burned. This is illustrated by examples in the original Paper. Moisture leads to a drop in the combustion temperature, which is a serious matter. It is also more difficult to obtain complete combustion of a mixture of aqueous vapour and gas with an excess of air of 25 per cent. than if gas alone is dealt with. It is also a well-known fact that the efficiency of a boiler depends in the first instance on the initial temperature of combustion, and if the latter is lower the efficiency of the boiler is certain to decrease. The first thing to be effected will be the evaporation per square foot of heating surface, which is certain to be considerably smaller if wet gas is used than with dry gas. Further, there is a greater loss in heat carried away in the flue gases, and the efficiency is lower.

Calculation in a case of gas with 2 per cent. moisture and another with 15½ per cent. shows that the latter gives:—

1. A drop of efficiency of nearly 9 per cent.
2. A drop in evaporation of more than 21 per cent.
3. A loss due to lower flame temperature, which the author has not attempted to calculate.

Thus, it is evident that an engineer who has to specify a producer plant, or a gas-cleaning plant, where washing of the gas is part of the process, should take care to specify the maximum amount of water vapour allowable in the gas supplied.

Contrary to a frequently expressed opinion the author does not believe that the dust in itself impairs seriously the heating value of blast-furnace gas; and the uncleaned gas has the advantage that it contains the sensible heat. The dust, however, may seriously affect the efficiency of the boiler. If two Lancashire boilers are run side by side, the one on cleaned and the other on uncleaned blast-furnace gas, it will be found that at first the results as regards both evaporation and efficiency are about the same. Where Lancashire boilers are to be fired, it will generally pay to install a gas-cleaning plant, even at the expense of the sensible heat which is lost in the cleaning process.

Conditions are much more favourable with water tube boilers, as with these it is often possible to clean the tubes without stopping the boiler. If liberal use is made of the steam lance, the proposition to put in a cleaning plant will certainly not be such a favourable one as in the case of Lancashire boilers.

So far as the author can discover, the cost of cleaning gas, inclusive of all charges, is about 2d. per 35,000 cubic ft., and is practically the same whether the wet or the dry process is used.

The sensible heat in blast furnace gas per cubic foot is approximately as follows:—

Temperature of gas, °C.	200	250	300	350	400
Sensible heat, therms per cubic foot ..	7	9	11	13	15

As cold blast furnace gas varies from about 90 to 110 therms per cubic foot the sensible heat is a large percentage of the total heat of

* Abstract of a Paper read before the Institution of Electrical Engineers.

the gas. Firing water-tube boilers with properly designed burners, and using the steam lance, say, twice a day to clean the tubes, the efficiency with uncleaned gas is certainly within 10 per cent. of the efficiency with cleaned gas—probably within 6 per cent. On the other hand, with Lancashire boilers the average efficiency over 4 or 6 weeks with uncleaned gas is very considerably lower than with cleaned gas.

The decision as to whether it will pay to clean gas must therefore be made for each case separately, and depends on the peculiarities of the gas and of the dust, as well as on the kind of boilers used.

HEAT TRANSFER.

Gaseous fuel as usually burned does not give the intense local heat and the heat-radiating surface of the coal fire. Rather the problem is that of a very hot gas which is cooled gradually as it travels through the boiler. The transfer of heat through a steel wall from hot gases to water consists of three parts—transfer of heat from gas to metal, transfer of heat through metal, transfer of heat from metal to water. The resistance to the transfer of heat in the second and third parts is exceedingly small when compared with the resistance to the transfer of heat from gases to metal. Again, the transfer from metal to water, if the metal has a clean surface, is also negligible compared with the gas-metal transfer.

The problem of finding the most satisfactory boiler for gas firing is to be solved by the boiler which abstracts the heat most successfully from the hot gases passing. There are several lines along which improvements can be made.

The first is to increase the surface exposed to the hot gases. The greatest resistance to heat transfer is at the hot surface of the tube, and therefore this hot surface should be increased greatly without necessarily increasing the wet surface. This has been done in some boilers by fixing projecting pieces or rings of angle iron inside the fire tubes, to increase the heated surface, and has resulted in a considerable improvement in heat transfer.

The second method depends on the fact that a square foot of heating surface at right angles to the gas flow is about four times more effective than a similar surface at 45 deg., and about eight times more effective than a similar area parallel to the gas flow—at ordinary velocities of gas. Deflectors or retarders of one kind or another are put into the boiler so as to cause the gases after they have been fully burned to impinge on the tubes as directly as possible.

A third method, and probably the one most commonly used, is to put surfaces of brick or other refractory material in the boiler in such a way that the flames play upon them. These surfaces are raised to a high temperature, and transfer the heat by radiation to the boiler tubes. Such surfaces, in order to give the greatest effect, must face the boiler tubes squarely, and must be as near as possible to these tubes. It is quite easy to heat surfaces at right angles to the line of gas flow, but usually very difficult to heat surfaces in the required position, as they generally have to be parallel to the gas flow.

The transfer of heat by radiation becomes much more rapid in proportion as the difference between the temperature of the two bodies concerned increases. Thus, the radiating surface should be at the highest possible temperature; and this again points to the use of the highest possible gas or air pressure in our burners in order to shorten the flame and make it more intense.

A fourth method depends on the theory that the difficulty of heat transfer from gas to metal is caused by a thin layer of cooled gas, which adheres to the surface of the metal and acts as a non-conductor. The stream of hot gases is made to scour very rapidly the surface of the tubes, and in this way the cooled gas is swept away and fresh hot gas is constantly applied. Very rapid heat transfer has been obtained by this means.

The author has had no experience with the Bonecourt boiler, but it is claimed by the makers that the heat is taken out of the gas by means of surface combustion. The author thinks it likely that the high velocity of the gases through the tubes, in close contact with the walls and heating the refractory blocks, may be sufficient to account for the high evaporation per square foot claimed. Unfortunately it is a costly matter to get the [illegible] that are used.

It will be noticed that [illegible] of the [illegible] methods involve either the use of power or the insertion of some [illegible] in the boiler. There is no doubt that boiler [illegible] [illegible] [illegible] [illegible] The author considers that [illegible]

in the case of blast furnace or producer gas, requires power which would only reduce the boiler efficiency by 1½ to 2 per cent., whereas the additional efficiency attained may be from 10 to 20 per cent.

TYPES OF BOILERS.

Lancashire Boilers.—A disadvantage of the Lancashire boiler when gas-fired in any of the usual ways is that the fall of temperature in the gases from one end of the flues to the other is not sufficient to set up good circulation of the water, as is done by the intense local heat of the fire when the boiler is hand fired. As to the output to be got from these boilers, the author has experience of regular evaporations of over 9,000 lb. per hour from and at 212° F. from ordinary 30 ft. by 8 ft. boilers, both with producer gas and with blast-furnace gas—*i.e.*, nearly 10 lb. per square foot of heating surface, which corresponds very closely to the evaporation per square foot claimed for the Bonecourt boiler at the lower suctions. This evaporation is far higher than what we should expect from a water-tube boiler.

It is a matter for experiment to find the best pattern of internal flue. The author's idea is to have a boiler with a considerable number of smaller tubes forcing the gas to burn at the highest possible temperature in each; and to have no obstructions in the tubes and no mechanical suction. He believes that such a boiler, properly insulated, would give at least as good results as the best water-tube boiler.

Water-tube Boilers.—A good boiler should evaporate about 80 per cent. of its load in the first bank of tubes, 15 per cent. in the second, and 5 per cent. in the third. The third bank is thus practically an economiser, and this accounts for the fact that the maximum evaporation of water-tube gas-fired boilers per square foot of heating surface is usually only 5½ lb. to 6 lb. per hour.

When judging a boiler it will be safe to take the results obtained from coal-firing, as we can be certain that if the same boiler is fitted with good furnaces and arranged for gas-firing it will do somewhat better. In any case where gas-firing is concerned the choice of the right combustion arrangement is much more important than the choice of the best boiler.

Another important question is the arrangement of superheaters in gas-fired boilers. When gas-fired boilers are arranged for hand-firing and gas-firing, the nozzles of the burners are, as a rule, too near the superheaters, so that in a good many cases the superheat [illegible] to the steam is too large.

The ideal boiler for gas-firing has not yet been developed. There is no doubt that a water-tube boiler which is arranged so that the gas can be fully burned before passing through the tubes, and where the gas stream is kept at right angles to the [illegible] of the tubes by careful baffling, is the best boiler we have so far. To get higher outputs from such a boiler per square foot of heating surface is [illegible] calling for more rapid combustion of the gas, with more intense flame temperature, and this can easily be arranged where required.

The author has bever come across a water-tube boiler with small diameter tubes, such as, for example, the Yarrow boiler, gas-fired. It seems probable from the theoretical point of view that the Yarrow boiler would give excellent results. As the tubes are only about 1 in. diameter, the proportion of heating surface touched by the gases, to the wetted surface of the tubes, is much larger than in the usual forms of water-tube boilers. As also the tubes are only about ¼ in. apart, the waste gases [illegible] at a high velocity. For these reasons the author would expect to get a high output and economical results with this type of boiler.

[illegible]

[illegible]

(To be continued.)

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D. S. & S.

Since the war began much has been said and written about the problem of the employment of Disabled Sailors and Soldiers. In certain directions much also has been done. Careful observation leads us, however, to conclude that one of the most important and difficult parts of the problem is being inadequately attacked. We refer to the finding of suitable, remunerative employment for those men who are disabled in one arm.

The view seems to prevail, even among those who ought to be well informed upon the matter, that there are plenty of well-paid "outlets" available for men who have lost an arm. It is not surprising that such a view should be held by the general public, impressed as they are by the accounts of the truly splendid work being done at Roehampton and similar institutions. One hears of the almost miraculous power which skill and ingenuity have been able to give to the artificial arm, and is led to think that for certain branches of skilled work an artificial limb is almost to be preferred to the natural arm. To this general impression are added the facts, first, that the pension for the loss of even the right arm is much less than the total disablement pension; and, second, that men with arm disablements are indeed finding employment.

We have good reason for stating, however, that the position is by no means so happy as is generally believed. Up to the present time conditions have served to gloss over the facts of the case. There has been a universal desire to help the men who have sacrificed so much; places have been held open and new places made, and the men have been welcomed even though their disablement has made them almost incapable of carrying out their duties.

But the number of arm-disabled men is sadly increasing, and the number available of odd billets under generous employers is sadly decreasing, and inevitably the time is approaching when the problem of the one-armed man will be very serious. We have heard much of War Pensions Committees, Trade Panels and Advisory Committees, but have been unable to discover that any definite schemes of training or employment have been devised.

The Ministry of Labour has issued, among others, a pamphlet upon the training of D. S. & S. in electrical sub-station work, in which it is stated that, in certain cases one-armed men may be trained for this work. But we learn on good authority, that although many arm-disabled men have already been placed in sub-stations and are earning good wages, the number of outlets in such stations for men with this particular disablement is distinctly limited.

It is perhaps necessary to emphasise that the problem appears to be widening in effect; we are not suggesting that it is a simple problem. To a man trained already in some profession such as that of engineering, literature, law or even medicine the loss of an arm might be a comparatively unimportant handicap, but the untrained or only moderately well educated man becomes by the loss of an arm seriously unfitted for any well-paid trade or occupation.

A principle which we are glad to see finding favour is that in fixing the wage to be offered to a disabled man the employer shall not take into consideration, either directly or indirectly, the amount of the man's pension, but shall offer the usual wage attached to the post offered. Unfortunately, this principle cuts both ways. From a stern business point of view it becomes impracticable to offer to an arm-disabled man any work in which his efficiency would be appreciably less than that of a two-armed man. But how many well-paid occupations can be named in which a one-armed man of limited education or training is as good as a two-armed? We cannot think of even one.

And the position that has to be faced appears to us to be this: There are no well-paid occupations for men of only moderate education in which the loss of one arm is not a serious handicap. There are, however, many occupations—such, for instance, as that of electrical sub-station attendant, traffic-inspector on the tramways, meter reader, numerous branches of electrical testing, store-keeper—in which the handicap, though serious, is not always vital, the chief effect of the loss of an arm being a reduction in speed of working. In indiscriminate competition for such posts as these the one-armed man is bound to stand but a poor chance against the two-armed. If, therefore, employment is to be found for the one-armed man, the occupations such as we have mentioned, instead of being thrown open to indiscriminate competition ought to be "ear-marked" as far as possible for the one-armed men. The "ear-marking" would be in the hands of a Government department which would then have an exact knowledge of the number and distribution of the outlets. This knowledge—obtained no doubt through the Trade Panels—would be conveyed to the various War Pensions Committees and would enable these to direct each man as to the course of training he should take and to guarantee to him a definite outlet on the satisfactory completion of his training.

It would be essential, however, that in any such scheme as we have outlined careful consideration should be given to the labour difficulties which would have to be met.

First, there is the difficulty of Trades Unions. These unions are a modern invention intended to give strength to the workman, to enable him to obtain fair treatment. To some extent they attain this object, but the cost to the workman is greater than he knows—for, to trades unionism he sacrifices his independence.

Apart from his trades unionism the workman has a good heart and an open hand. None is so ready as he to help our disabled men in the long heroism that begins with the return to civil life. But, as a member of a trades union, he has neither heart nor hand to offer to his wounded brother. We regret to say that cases have actually occurred in which a trades union has given written orders to its members that they shall refuse to instruct any disabled sailor or soldier in the processes of their trade.

On the other hand, the unions enforce the rule that standard rates of pay shall be given to workmen irrespective of their individual qualifications or disabilities. They are rightly careful that the employer, seeking cheap labour, shall not exploit the pensioned disabled man. But they seem to overlook the fact, so obvious to the employer, that in most cases, the disabled man is perforce a less effective or a slower workman than his able-bodied brother, and ought thus to be paid a correspondingly lower wage.

We fail to see how any permanently satisfactory solution of the problem of the employment of disabled men can be reached until the trades unions see their way, first, to welcome the disabled man and give him a helping hand, without inquiring what may have been his trade before the war; and, second, to grant to the employer the right of basing a man's rate of wages upon his rate of working.

THE WORKS OF MESSRS. ABBOTT, ANDERSON & ABBOTT.

BRITISH ENTERPRISE IN THE MAKING OF INSULATING CLOTH.

In what follows we have pleasure in drawing the attention of our readers to another development tending to make the electrical industry of this country independent of imported materials. We refer to the new works of Messrs. Abbott, Anderson & Abbott, for the manufacture of insulating cloth.

In the early days of electrical machinery design it was soon recognised that the various fabrics used for wrapping around conductors must be treated with some kind of material to reinforce insulation and to act as a protection against the absorption of moisture, the presence of moisture being the root cause of electrical leakage and breakdown in all electrical apparatus. In those early days the design of machines was liberal as regards copper and iron, so that material like sealing wax, varnish, and shellac were sufficient to keep the insulation of the apparatus in fairly good condition.

FIG. 1.—THE TOWER BUILDING FOR DRYING THE IMPREGNATED FABRIC.

Modern requirements have demanded far more attention to the selection of insulating materials and the peculiar properties of the drying or oxidising oils, particularly linseed oil, have been taken advantage of in connection with the preparation of insulating varnishes and insulating fabrics. Linseed oil has the property of undergoing a chemical change by the absorption of oxygen very slowly at the ordinary temperature, and more quickly when subjected to heat and in the presence of certain metallic compounds, which have the effect of determining this oxidation or drying. Such metallic compounds are known as driers or siccatives.

Films of oxidised linseed oil, or the combination of this oil with certain gums, possess remarkable elasticity, flexibility and insulating properties, both as regards disruptive strength and insulation resistance, and electrical manufacturers took advantage of these properties of linseed oil or varnish prepared from it to coat fabrics like cambric, cotton drill and duck for use as wrappers for electrical windings. The process employed was crude, consisting of dipping sheets of the fabrics to be treated in the oil or varnish and subsequently drying out in a [illegible]. The [illegible] properties of fabrics so treated became so [illegible] that a separate industry for their manufacture sprang up, first in the United States of America (Empire Cloth), later in Germany, [illegible] and Switzerland.

The manufacture of [illegible] in the United Kingdom is an industry which has sprung up [illegible] and the demand [illegible] did not apparently warrant putting down a plant in this country for their production. [illegible] until 1907 that Messrs. Abbott, Anderson & Abbott, Ltd., of [illegible], London, E., and Harpenden, Herts, [illegible] of oilskins and waterproof clothing, set earnestly to work to produce this class of electrical material.

The problem was no simple one from the technical point; moreover, our free imports system did not encourage the manufacture of materials which were coming into this country in the form of the surplus output from the factories in the United States of America, Germany and Switzerland.

The technical difficulties consisted in obtaining the right kind of cotton cloth for treatment and the proper varnish for coating it, also the design of the necessary machinery to provide economical working was also a matter for much thought and ingenuity. All these difficulties were surmounted by Messrs. Abbott, Anderson & Abbott, and in spite of the keen competition of the imported material they had a steadily increasing business up to 1916, when the whole of their Harpenden works was unfortunately destroyed by fire; thus the United Kingdom whilst at war was left entirely dependent on foreign countries for the supply of this most important form of insulating material.

The firm has rebuilt its works as quickly as possible under war conditions, and has now erected an entirely new and up-to-date plant, capable of turning out 750,000 yards of finished cloth per annum, and extensions are now in contemplation whereby this output will be more than doubled. The quality of the product is equal in every respect and in some ways superior to the imported grades.

Last week we had an opportunity of inspecting the new works and seeing the various materials in the process of manufacture. Taking first the material that is used, it is necessary that the cloth should be of the best quality cambric cotton. This is treated by the manufacturers with size and a suitable dressing, after which it is calendered. It is essential that the finished cloth should be free from fluff, and a great deal of the success of the final product depends upon the cotton manufacture being able to supply a really suitable article. The cloth is cut on the bias so that the tape when finally obtained winds evenly and does not tend to have a greater tension on one edge than on the other. Further, the seams for joining together the various lengths are made at an angle, and special sewing machines are used for the purpose.

FIG. 2.—A [illegible] MACHINE.

The [illegible]

The construction of the [illegible] building presents some features of interest. [illegible] Messrs. W. [illegible]

The [illegible]

cutting discs that may be necessary for cutting the whole width into a series of tapes. This machine runs at such a rate that one gross yards of each tape is cut and wound in three minutes. Generally each of the reels on which the tape is wound carries one gross yards.

The dielectric strength of the cloth averages from 800 to 900 volts a.c. per mil.

The war has proved how important it is that Great Britain should be capable of manufacturing her own requirements in all materials necessary for maintaining her commercial supremacy. Varnished fabrics and tapes are essential for the heavy electrical machinery industry and varnished silks for the magneto and instrument trade, and it is to be hoped that British manufacturers will give all the support in their power to encourage Messrs. Abbott, Anderson & Abbott's enterprise, at any rate for the duration of the war, when our shipping can be so much better employed than bringing this material from overseas. We desire to thank Messrs. Abbott for their courtesy in showing us the various details of their manufacture, and we hope they will achieve success, not merely during the war but in the more important period that must follow.

MR. H. DICKINSON'S PRESIDENTIAL ADDRESS TO THE LIVERPOOL ENGINEERING SOCIETY.

I am sure you will agree with me that the conditions under which we find ourselves offer plenty of scope for the engineer of to-day. The war has thrown a great responsibility upon the shoulder of the engineer. Upon him devolves the work of inventing and constructing the many and varied devices, which will so materially help to bring the war to a successful and victorious conclusion.

It is therefore incumbent on the engineers of the country to appreciate to the full what is before them. The problems to be faced after the war will be many.

Some of the more important features of immediate value to the consumer and producer affecting the manufacturing side of industrial life will be :—Organisation for definite and specific purposes; construction, providing for great expansion in production; greater specialisation in production; and increase of mechanical performance with a view to more rapid and largely increased production.

It will also be necessary to see that the training of the young engineers is thorough, and that a larger proportion of our young men are encouraged to take up the engineering profession.

A closer bond between the workshop and the university is essential so that the training of the young engineer may be carried out on the lines which will make him of the greatest use to the manufacturer. On the other hand, the manufacturer must be encouraged to appreciate the value of a thoroughly efficient scientific training, and be prepared to reward such services adequately.

In the past the policy of the country has led to disorganisation; the hope in the future is in organisation. In recent years the methods of handling commerce adopted by some of our keener competitors have undergone a marked change; in fact, a process of evolution has been taking place which this country has not sufficiently appreciated. Advancing from the individualistic state, we have seen combination in certain lines of industry, and in the case of several of our competitors, we see to-day the main lines of industry combined, and centralised through large financial systems, which again are intimately connected, and behind all a sympathetic Government which is always ready and eager to use its immense power and influence to encourage commercial development for the nation's benefit, realising as it has done that the nation's welfare depends so largely upon a successful commerce.

On looking round, the first thing that appeals to one as being inconsistent in our methods is the fact that commerce, being the foundation stone upon which the whole national edifice stands, is not represented by a Minister. We have in the Board of Trade a Department fulfilling its duties faithfully and well within its prescribed limits, but it must be remembered that these duties are mainly restrictive.

Our present system assumes that commerce can look after its own interests best. My reply is that commerce cannot. It has not the power to frame laws for its own advancement. Neither can it prevent laws coming into being which are detrimental to its [illegible] development.

The Government which represents the full power and strength of the nation has in the past shown a lack of sympathy with commerce which is the [illegible] source from which that power and strength is derived.

What is wanted is an executive Department giving its whole and undivided attention to trade questions. Such a Department could gather information from all quarters of the globe through properly organised officials. Such information would be made available and useful to our manufacturers and commercial men. To encourage the [illegible] up of new lines where the conditions are suitable, to [illegible] and watch over legislation with a view to seeing that commerce was allowed as free a field as possible for development, to investigate the possibilities of our Colonies, and to place the results of these investigations before our manufacturers and commercial men, to encourage research and the furthering of scientific knowledge.

I will now proceed to consider the branch of engineering with which I am more particularly connected.

The author then traces the history of electricity up to 1900, when a number of Power Bills were introduced. Certain provisions were drawn up for embodiment in the Acts, one very important provision being that energy should not be supplied by the company in the area of any authorised distributor, except with the consent of the distributor; but a proviso was inserted that the consent should not be unreasonably withheld. The results obtained by the power companies have not come up in most cases to the expectations of the promoters, the development having been slower than was anticipated for several reasons, the principal of which are :—

1. That the power companies being excluded from the more densely populated districts in most cases had to commence operations where the load was very scattered, and owing to the extensive area covered, the expenditure incurred especially on mains was relatively heavy.

2. The prices charged were not in most cases sufficiently low to encourage the smaller authorities to purchase in bulk.

3. The smaller authorities felt that in the event of purchase in bulk they had no security that in the future they would obtain the full advantage they might reasonably expect, from the power companies obtaining lowing working costs, dueto increasing load and the use of more efficient plant.

This legislation has resulted in the supply of electricity throughout the country being mainly divided between a large number of undertakings, each operating over a comparatively small area. The supply in these limited areas usually started in a very small way, gradually extending to the boundaries, and in many cases adopting different systems of supply.

With the advent of the polyphase system the older direct-current stations have in many cases been converted into sub-stations and supplied from a central generating system, and in the case of the single-phase supplies where the power requirements are large a polyphase system has been adopted.

Concurrently with this development a constant change has been taking place in the type of generating plant. Starting with the slow speed engine as the prime mover, then we find the high speed and size, the limits of which are prescribed owing to its reciprocating motion. Then the steam turbine was brought into use, and owing to its rotary motion, speeds are obtained which were impossible with the older form of prime mover, the tendency all the time being towards higher speeds. And to-day there are turbines of 5,000 kw. running at 3,000 revs. per min., and manufacturers are prepared to offer turbines of 10,000 kw. running at this speed, and by mounting two 10,000 kw. generators on one shaft, a 20,000 kw. set running at 3,000 revs. per min. is now possible.

In the early days a 200 kw. set was about the standard size, and a [illegible]00 kw. set considered a very large unit. To-day sets of 15,000 kw. and 25,000 kw. are being installed in this country, and units of very much larger size are talked of abroad.

In order to get an idea of the progress made, the following particulars of six towns in this district will serve as examples :—

For the year ending March, 1907, the aggregate number of units generated by these six towns was 77,000,000. The number generated for the year ending March, 1917, was 285,000,000, nearly 400 per cent. increase.

The costs, including capital charges, had reduced from 1·326d. per unit in 1907 to 0·897d. per unit in 1917, in spite of an increase of [illegible] to 100 per cent. in the price of fuel. The average price obtained for all supplies had reduced from 1·60d. to 0·97d. per unit.

The main part of the development of electric supply in recent years has been for power purposes. The demand during the last three years for war service has been very great, and the authorities have been able to cope with this greatly increased demand promptly and economically.

Electric steel produced in electric furnaces is being made in considerable quantities in different parts of the country, particularly in Sheffield, where furnaces have been installed with a capacity of something like 30,000 to 40,000 kw., and the production of this class of steel will be in the neighbourhood of 100,000 tons per annum.

This class of business shows signs of considerable development, and by its use turnings and scrap can be converted into very high-grade steel. Developments are also taking place in this country in the manufacture of nitric acid from the air, by means of an electric furnace. The uses of nitric acid for the manufacture of explosives and fertilisers makes this development one of very considerable importance.

The largely increased output that will be necessary to enable us to make good the ravages of the war will cause a great development in manufacture, which in turn will throw a very large increased load on the supply undertakings, many of which are now running their plant up to its limits.

It is to be hoped that the authorities will at the earliest possible moment enable the undertakers to secure extensions of plant in good time to meet this growing demand.

The foregoing gives a very general outline of the situation, and shows clearly that we have advanced through the experimental stage, and are now in a position to launch out on extended lines and co-ordinate and consolidate the work already done.

The encouragement to launch out on broader and more extended lines is the greater because the essential factors for success are available, viz.:

1. The steam turbo-generator low in capital costs and high in efficiency.

2. The polyphase system eminently suitable for main generation transmission and distribution.

3. The certainty of a very largely extended demand for railway for power supply, for domestic use, and for many other and varied purposes.

The Government are considering many questions in relation to post-war conditions, not the least important of which is the position of the electrical trades, and the power supply of Great Britain.

Committees have been appointed to deal with the problems, one Committee having reported, and the Committee on Power Supply is now sitting.

It is encouraging to note that in recent years there has been a tendency to greater standardisation than formerly, and to-day for three phase work a standard of 50 periods per second is very largely adopted.

Recently a scheme of interlinking has been worked out, and a report presented for Lancashire by a number of the engineers in charge of the undertakings in this area. In another district covering over 1,000 square miles a proposal has been made to co-ordinate all the electric supply in this area. Both these schemes suggest public ownership, but differ as to method of operation. In one case the authority would operate and in the other the operation would be undertaken by a company under agreement.

Mr. Ferranti, in his presidential address before the Institute of Electrical Engineers some years ago, suggested that the future would see the generation of electric supply for the country carried out in a comparatively few large generating stations situated in the most suitable sites for obtaining water and coal. It is possible that ultimately this position may be arrived at, but many difficulties have to be overcome before this result can be achieved.

If electrical development in this country is to attain to its maximum plane of usefulness on the lines indicated transmission lines over wide areas carrying high voltages will have to be installed. Transforming stations will have to be placed at suitable sites of the route where the energy will be transformed to lower pressure for distribution. [illegible]

[illegible]

often be effected. These figures show conclusively the necessity for providing the facilities which will enable these great economies to be effected.

The difficulties that undertakers experience in the construction of overhead lines are due to refusal of landowners to grant wayleaves; to high charges demanded in many cases for wayleaves; to powers of local authorities to refuse consent to the erection of overhead lines; and to delays in obtaining consents.

It is curious that a statutory undertaking is in a worse position than a non-statutory undertaking, which is an anomaly requiring rectification. In other countries the facilities for obtaining wayleaves have been considered, and laws are in existence which facilitate the erection of these transmission lines.

In most of the European countries where a high state of industrial development has taken place, powers to acquire compulsory wayleaves are in existence.

From the foregoing it will be appreciated that:—

1. The question of facilitating wayleaves for electric transmission lines is urgent.

2. That other countries are ahead of us in this matter.

3. That in regard to sewerage and water, and in the case of telegraph lines there is a precedent in this country.

It is to be hoped, therefore, that this very important matter will receive the most careful attention of the Government in the immediate future, and so assist the great developments of electric supply that is bound to take place, provided the facilities are afforded to make this development possible.

CORRESPONDENCE.

ENGINEERING ETIQUETTE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with much interest the note in your issue of last week under the above heading, referring to Mr. C. H. Wordingham's Presidential Address, in which he expresses the view that there should in future be a greater observance of etiquette between engineers in their respective spheres of work.

In another Paper I notice that Mr. Wordingham has been reporting to the Town Council of Leicester on the proposed extension of their works, and has recently had a meeting with the Corporation to explain his proposals.

Now, sir, Mr. Wordingham holds the important position of electrical engineer-in-chief to the Admiralty, a post that should be sufficient at the present time one would imagine to occupy him entirely.

Is it, therefore, quite in keeping with the spirit of his Presidential Address that he should compete with consulting engineers, who owing to the war are [illegible] occupied as Mr. Wordingham [illegible]

Surely the views that Mr. Wordingham expresses should lead him to [illegible]

Nov. 19. [illegible]

COMBINATION BY MANUFACTURERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR, [illegible]

belief, otherwise our efforts remain too parochial in character, and we lose that wide vision so necessary for the future of British trade.

There is such a thing as unhealthy competition, and when we view the sorry spectacle of a score of more firms, each making, among other things, a certain article and each competing one with another for a portion of a total yearly trade in the product which may not be more than a few thousand pounds in value, how is it possible to argue that it has the tendency to cheapen manufacture? Its effect is just the reverse.

If we are again to attain the proud position our trade once occupied we have got to adopt any and every means that will stimulate our factories to their greatest productive capacity. Syndication or co-ordination of effort between firms in the same trade will prove to be the greatest of all influences that will bring about the desired end. The operations of individual firms in each trade should be so arranged that the whole combine would act as one body. This would secure the interests of individual manufacturers and allow them to devote all their energies and all their initiative to that one great necessity—Production, instead of having to spend half their time in fighting local competition and for ever struggling among themselves for a scrappy share of the existing trade in almost every line produced.

One is reminded of the old phrase, "A house divided against itself cannot stand," and surely this is the position of a great many trades in Great Britain to day, and most certainly they will never withstand the terrific "offensive" we are to expect from international competition in the future if we do not combine to present a bold and united front to other nations when struggling again for trade supremacy of the world.—We are, &c.,

Howard F. Smith, Director.
Birmingham, Nov. 12. Smith & Davis (Ltd.)

THE METRIC SYSTEM.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I am very pleased to see it stated in the daily press that the Institute of Bankers, the Association of Chambers of Commerce and the Decimal Association have unanimously agreed to adopt the pound sterling as the unit for the decimal coinage, and that it is to be divided into 1,000 parts. My object in writing this letter is to protest against the thousandth part of a pound being called a mil, as this term is already in use in engineering for designating the thousandth part of an inch. Why not adopt the word "kil" derived from the Greek Xilioi, a thousand?—I am, &c.,

London, Nov. 14. H. C. Silver.

MR. A. PAGE'S ADDRESS TO THE SCOTTISH LOCAL SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

At the opening meeting of the Scottish Local Section of the Institution, held at Glasgow on November 13th, Mr. Archibald Page delivered his inaugural address as chairman. Taking as his subject "The Electricity Supply of Scotland," Mr. Page at the outset summarised the recent activities of the Government as regards the reorganisation of electricity supply throughout the country with the double object of conserving coal and of assisting British industry to meet foreign competition. During the last 12 years electricity supply authorities in Scotland had taken over a fourth of the total power load, and it was now the exception for a new industrial concern to put down its own generating plant. With the increase in output had come a reduction in the price per unit, which was now 46 per cent. less than it was in 1908. The consolidation of existing interests, the erection of super-stations and the price of coal could not be dissociated from certain lines of development, which Mr. Page proceeded to discuss in detail. The latter were:

1. Efficiency of Transformation from Coal to Electricity.

The thermal efficiency of the generating stations in the area 25 miles round and including Glasgow during the last financial year was only 8·6 per cent. It was argued that this figure could be raised to 17 per cent. on large systems. In any case, after making ample allowance for distribution and stand-by losses, with up-to-date stations they were assured of a figure of 15 per cent. coal to electricity at consumers' terminals, which would represent a saving of 43 per cent. in coal, equivalent in money at present prices to £181,000 per annum. The possibilities thus presented were largely due to the improvement in design of turbo-alternators. The overall thermal efficiency of the set installed at Glasgow in 1904, assuming good boiler house conditions and without allowing for auxiliaries, was 11·8 per cent. In 1908 when the speed was doubled they got machines giving a thermal efficiency of 13·9 per cent. This was followed in 1912 with units twice the size of the original sets and gave a figure of 15·6 per cent. It was expected that the three 15,000-18,000 kw. sets on order for the West of Scotland district would be in commission for next winter's load, the guaranteed efficiency at full load being 21·3 per cent. The steam pressure for supply to these turbines was to be 250 lb. per square inch, superheated to 650°F. With the substitution of steel for cast iron for turbine bodies and valve chests they would probably have still higher pressures and temperatures, and with the limit of temperature as regards fittings and joints, the available heat drop per lb. of steam would be materially increased. He held the view that stations working on low vacuum and with no access to an abundant supply of condensing water should be shut down as soon as possible. As the water available for condensing purposes on the non-tidal portion of the Clyde near the Lanarkshire coalfield would only be sufficient at 2[illegible],000,000 gallons per hour, the most [illegible] station there would be 250,000 kw. If more than 250,000 kw. were required another station would have to be erected at the tidal part of the river. There had been a general shortage of boiler plant in generating stations for which boiler-makers were partly responsible, as they had tended to put forward too high a ratio of heating surface to grate area for a given duty.

The ideal ash handling plant had not yet been found, but if half the time at present spent on upkeep of such plant could be saved, boiler house efficiency would be materially improved. In a super-station of 250,000 kw. the coal and ashes handled per day would be 2,000 and 300 tons respectively. Railway sidings, storage of coal, facilities for unloading in frost and foggy weather were each problems in themselves. An advantage of having the station on the tidal part of a river was the ease with which ashes could be taken out to sea.

Provision against sudden increase of load due to descent of fog or when a thunderstorm during summer breaks over a city area was a serious obstacle in seeking to effect further economy. An analysis of output of undertakings in the district showed lighting units to be 7 to 15 per cent. of the yearly output. The maximum load due to lighting might, however, be as high as 40 per cent. of the total, and he had known the load on a station increase in five minutes from 15,000 kw. to 23,000 kw. The newer designs of mechanical stoker helped to meet this. By using a combination of forced and induced draft, the stoker could carry a heavy bed of fuel, this fuel in time of emergency acting as a kind of thermal storage. The rate of feeding green coal could be specially accelerated, and with enough suction to pull the gases through the resistance of the boiler elements together with proper design of combustion chamber, evaporation in the boiler could be increased 100 per cent. in five minutes. With increased diversity factor and the lighting load reduced to a negligible proportion of the total output, this problem of sudden increase of load would be greatly minimised. Boiler units were now being built to evaporate 100,000 lb. of water per hour, in which the ratio of B.H.S./G.A. was 33/1, the economiser fully half H.S. of boiler, and superheater surface fully one-third that of the boiler. Two such units would suffice for a 15,000 kw. turbine with a margin for overloads. After allowing for stand-by losses and power to drive auxiliaries, it was possible to get 80 per cent. efficiency continuously out of a well designed and properly run boiler plant. With the present available knowledge he did not hope for much help from low temperature carbonisation of coal in connection with the generation of electricity, but they would await with interest the results of the investigation which the Fuel Research Board were about to carry out at East Greenwich.

In the transition stage problems of long distance transmission would require careful consideration. Distribution losses on fairly extensive systems at present amounted to 10 per cent. of the total units generated, but losses would tend to increase.

The use of alternating current apparatus should be extended. Conversion from alternating current to direct current had a bad

effect on overall efficiency and seriously affected the reliability of the supply.

II. WASTE HEAT AND WATER POWER.

The two main sources of waste heat were blast furnaces and coke ovens. In 1916 the average number of blast furnaces in Scotland (and these mainly in the west) was 74, with an output of 1,144,768 tons for the year. Assuming the figure of 1 ton of coke used per ton of iron, and 34 per cent. of the total heat carried away with waste gases, with ample provision for works purposes, 25 per cent. would be left, which at 10 per cent. overall thermal efficiency represented 207,000,000 units of electricity. The difficulty presented by the scattered location of the furnaces would be largely met by a common system of distribution for Scotland.

There was a considerable amount of water power, particularly in the North and North-West of Scotland. Prof. Forbes had put the possibilities in Scotland as equal to 1,000,000 H.P. In the vicinity of the Caledonian Canal there was an aggregate of 215,000 H.P., which could be maintained if the load factor was 50 per cent. The distance from the Clyde district to the Caledonian Canal was relatively not great, and assuming a total cost of £40 per kilowatt, including transmission, water power would be a factor in cheapening electrical energy in Scotland.

III. INCREASE OF OUTPUT.

The fact that only 24 per cent. of the power used in Scotland was generated electrically showed they had not nearly reached saturation point. The district of Chicago, with a population of 2½ millions, used 480 units per capita, whereas in the West of Scotland the parallel figure was 160 units.

Mr. Page then proceeded to discuss the newer uses of electricity under the following heads:—

1. *Railway Electrification.*—The consumption of coal on Scottish railways for locomotive purposes last year was 2,187,000 tons, and electrification would reduce this to the extent of 40 per cent., which from the electrical standpoint meant an output of 1,000,000,000 units.

2. *Metallurgical Processes.*—Although there were only four electric furnaces in Scotland many such furnaces were on order. The size as well as the number of these furnaces was increasing, and 20-ton electric furnaces were now in use. Although comparative costs of producing heat did not tell in favour of electricity, the incidental advantages of the electric furnaces were so great as to hold out bright prospects for large demands for electric energy from this source. These advantages were summarised as control and wide range of temperature, temperature obtained without interfering chemically with the process of refining, high-class steel producible from low-grade scrap, quantity of ferro-alloys reduced, refining process carried to any degree required, smaller furnaces involving lighter structures to give equal output, and refractory material and labour costs lower. Had the 1,750,000 tons of steel produced in Scotland last year been made electrically it would have meant a consumption of 1,100,000,000 units.

3. *Chemical Processes* included the fixation of atmospheric nitrogen by special forms of the electric arc and the production of calcium carbide. These and other chemical processes which were being developed would utilise an enormous amount of electrical energy.

4. *Agriculture* was likely in the immediate future to afford a large outlet for electricity. Electro-culture had shown increase of yield much in excess of the normal, and with apparatus of robust construction agricultural development would be accelerated by electricity being applied to such apparatus.

5. Other promising developments were the electric vehicle business, electric welding, and heating, cooking and other domestic applications of electric energy.

IV. STANDARDISATION.

Much good work had been done by the British Engineering Standards Committee, and the active co-operation of American interests would be helpful. Linking up schemes were impeded by lack of uniformity in periodicity. Fifty cycles would probably be adopted as the standard. Three of the 13 alternating current concerns in Scotland had adopted 25 cycles, and they had an aggregate plant capacity of 113,000 kw., which was being rapidly extended, while the other 10 Scottish undertakings, with one exception, had a 50-cycle periodicity, their plant capacity being 60,000 kw.

V. TAXATION.

Electricity supply concerns, as compared with other trading concerns, were taxed unduly heavily for local purposes. The present principle of taxation applied to public undertakings [illegible] and it was to be hoped that the matter would be [illegible] the [illegible] of the Electric Power Supply Committee.

Prof. Magnus Maclean proposed a vote of thanks to Mr. Page, which was received with acclamation.

PHYSICAL SOCIETY.

A meeting was held on the 9th inst., at the Imperial College of Science, Prof. C. V. BOYS, F.R.S., President, in the chair.

The PRESIDENT referred briefly to the great loss which the Society had sustained since the last meeting in the death of its treasurer, Mr. W. Duddell, F.R.S.

Mr. R. S. WHIPPLE, of the Cambridge Scientific Instrument Co., said he had known Mr. Duddell since 1898, in which year they had made his first oscillograph. Since then he had been in frequent contact with him, and could conceive of no one with whom it would be a greater pleasure to work. He was a craftsman of the first order himself, and took the greatest pains to assist in the manufacture of his inventions, pointing out the pitfalls, and showing how they were to be overcome. Scientific instrument makers owed him a great debt. He had had the privilege of being associated with him on the Council of the Physical Society for some years. The Annual Exhibition of apparatus owed its initiation to him, and its success was in large measure due to his energy and persuasive powers. He had also urged the separate publication of the Society's "Proceedings," and had been of inestimable service to it in many ways. His death was a great loss to the Society and to science.

A Paper, entitled

"On the Thermo-Electric Properties of Fused Metals,"

by Messrs. C. R. DARLING and A. W. GRACE, was read by the former.

In a previous Paper ("Proceedings," Vol. XXIX., Part I.) the authors described experiments with bismuth, the apparatus then used only being capable of furnishing readings up to 560°C. Methods have now been devised in which the metals examined may be heated in the tube of an electric furnace, and observations made up to the temperature limit of the furnace. The metals experimented with were lead, tin and antimony up to 1,000°C., and zinc and cadmium up to temperatures approaching the boiling point. No change in thermoelectric properties was noticed at fusion, except in the case of antimony, which, like bismuth, shows an abrupt bend in the E.M.F. temperature curve at the melting point, 632°C. This exceptional behaviour of antimony and bismuth is in keeping with the anomalous properties of these metals, both of which expand on solidification; and it is suggested that an allotropic change occurs at fusion in these metals.

In the case of lead which is used as the reference metal in thermo-electric diagrams, it is shown that extrapolation of lines in the diagram beyond 300° led to serious errors, and that although at low temperatures the E.M.F. [illegible] parabolas, the departure from this shape above 300° is so marked as to render thermo-electric [illegible].

Mr. WHIPPLE said that [illegible] commercial importance [illegible] tained of the thermo-electric properties [illegible] have while it was still in the molten state [illegible] adding one or other of the constituents [illegible] with any prescribed thermo-electric properties [illegible] to be allowed to cool, and [illegible] right, it had to be melted [illegible] was a troublesome method. [illegible] low vapour pressure of tin [illegible] had suggested a tin [illegible] about 1,000° [illegible] mometers. [illegible] an index [illegible]

[illegible]

The PRESIDENT said it was a [illegible]

Dr. W[illegible]

[illegible]

Mr. D[illegible]

[illegible]

A Paper, [illegible]

"Triple Cemented Telescope Objectives,"

by Mr. T. [illegible], was read by the [illegible].

The Paper [illegible]

sign for all optical glasses when the surfaces are spherical. The best standard attainable varies very little over a considerable range of glasses. Diagrams show the variations in the curvatures as the glasses are varied for refractive index and dispersion. Contrary to the general belief, it is found that the objectives with least second order aberrations (absolute values) are not those with the least curvatures for their refracting surfaces.

PARLIAMENTARY INTELLIGENCE.

IMPORTS AND EXPORTS.

A Bill entitled "Imports and Exports (Temporary Control) Bill," which will continue, with modifications, for a limited period after the termination of the war, certain powers in relation to imports and exports, was read a first time in the House of Commons on Monday.

In a memorandum issued with the Bill it is stated that the practica effect of the measure is to simplify and continue for three years after the termination of the war the powers which His Majesty has exercised during the war as regards the control of imports and exports. Otherwise these powers would to a great extent lapse as soon as a state of war ceased.

The present powers of His Majesty as to prohibiting the importation and exportation of goods are as follows:—

1. Under sec. 43 of the Customs Consolidation Act he has power by Proclamation or Order in Council to prohibit the importation of any goods, but not to prohibit the importation of goods of any specified origin.
2. Under sec. 8 of the Customs and Inland Revenue Act, 1879, he has power to prohibit absolutely the exportation of certain specified goods (arms, &c., and food), and this power has been extended by the Customs (Exportation Prohibition) Act, 1914, to all goods of any description, but the extension has effect only while a state of war exists.
3. Under the Exportation of Arms Act, 1900, he has power (when for specific reasons he deems it expedient) to prohibit the exportation of arms, &c., to any country or place named in the order, and this power has been extended while a state of war exists (a) To the exportation of all goods of any description, by the Customs (Exportation Restriction) Act, 1914; and (b) to the exportation of goods to any such country or place unless consigned to particular individuals, by the Customs (Exportation Restriction) Act, 1915.

The restriction of imports and exports is in practice subject in all cases to any licence which may be granted to import or export.

PATENTS, DESIGNS AND TRADE MARKS BILLS.

On Monday the President of the Board of Trade (Sir Albert Stanley) [illegible] the Patents and Designs Bill for the purpose of amending the [illegible] Designs Act, 1907, and also the Trade Marks Bill to [illegible] Trade Marks Act, 1905.

THE TRAMWAY COMMITTEE.

In the House of Commons on the 14th inst., the President of the Board of Trade [illegible] stated, in reply to Mr. Gilbert, that the object of the [illegible] had been appointed to deal with tramways [illegible] undertakings, but to meet the needs of those [illegible] essential to the prosecution of the war. [illegible]

WAR INVENTIONS.

[illegible]

[illegible]

Government would be decided by the Government Department concerned, subject to the approval of the Treasury. They further provided that, in deciding those terms, regard would be paid to any facilities in originating, working out and perfecting the invention which the inventor may have enjoyed by reason of his official position.

TRADING WITH THE ENEMY.

In the House of Commons on Thursday last Mr. Wardle stated, in reply to a question by Mr. Butcher, that steps were being taken to collate the information as to methods adopted by enemy companies and firms derived from the administration of Trading with the Enemy Acts.

Non-Ferrous Metal Industries Bill.—This Bill, which will restrict temporarily the persons who may engage in business connected with certain non-ferrous metals and metallic ores, was introduced in the House of Commons on Monday and read a first time.

LEGAL INTELLIGENCE.

Irish Telephone New System (Ltd.) v. Walter Bright (Ltd.)

Before the Dublin Recorder last week plaintiffs claimed £31. 17s. 3d., alleged to be due under an agreement between the parties of June 10, 1915, for the installation of a telephone system in defendants' works.

Mr. T. Brown said plaintiffs relied upon the contract made with Mr. James Shanks, managing director of defendant company, by which he agreed to contribute 2d. per foot on all additional wire over 100 ft. for each instrument. Five instruments had been installed, and 2,563 ft. of wire had been used in the installation, which was completed in December, 1915, and the balance of the claim was for rent due to that date.

Mr. J. O'Connor said the defence was—first, that the agent (Mr. Lowe) who induced the defendants to sign the contract, did so by alleging that there would be no cost whatever to defendants except the rental, that the instruments would be fitted up free of any extra charges, and on that inducement Mr. Shanks signed the contract, never dreaming that no more than the 100 ft. of wire allowed for each instrument would be needed. The second defence was that the instruments as erected were never at any time efficient.

Mr. Arthur Porter, C.E., gave evidence of the inefficiency of the installation, and said that in his opinion it could never be maintained efficiently.

Mr. Shanks also gave evidence, and the Recorder dismissed the claim, with costs, stating that he was fully convinced the installation was never efficient and could never be made so.

Re Bosch Magneto Co. (Ltd.)

On Tuesday Mr. Justice Younger heard the petition of the Board of Trade for the winding up of Bosch Magneto Co. (Ltd.) under the Trading with the Enemy (Amendment) Act, 1916.

Mr. Austin Cartmell said that at the outbreak of the war over 49,900 of the company's shares were held by Germans, and 50 by one gentleman in London. It was essentially a German-owned company, and it was formed for carrying on a German business. Messrs. Bosch and Klein and the English gentleman to whom he had referred were the only directors. After the outbreak of war the German directors transferred certain large powers to the English gentleman. The company had now been ordered by the Board of Trade to be wound up. The funds now in the hands of the Controller amounted to nearly £200,000. There were certain questions affecting the London corporation which could only be dealt with in the winding up of the company.

Mr. Galbraith said the London corporation claimed to be creditors for a very considerable amount, and they desired that the winding up should take place at an early date.

His Lordship made the order.

VOLUNTEER NOTICES.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Oxford-street, W. 1.

Orders for the Week:

Officer Commanding, Lieut.-Colonel C. B. Clay, V.D.

Officer for the Week.—Lieut. W. J. A. Watkins.

Next for Duty.—Second Lieut. H. G. Golding.

Drills.—Week ending Saturday, Dec. 1, 1917.

Monday.—No. 3 Company, Left Half, Recruits, Signalling, 6.30.

Tuesday.—Physical Drill and Bayonet Exercise, 7.30.

Wednesday.—No. 1 Company, 6.30.

Thursday.—No. 2 Company, 6.0. Signalling, Ambulance, 6.30.

Friday.—No. 3 Company, Right Half, Recruits, 6.30.

Saturday.—Commandant's Parade, 2.45 at headquarters, uniform, for route march and drill. Compulsory for A, B and C men unless special leave is obtained.

Musketry.—Belvedere-road, Tuesday, Wednesday and Thursday, 5.30 to 7.0.

Note.—The Medical Officer will attend for examination of recruits on Thursday, at 6.0.

Unless otherwise indicated, all drills will take place at headquarters.


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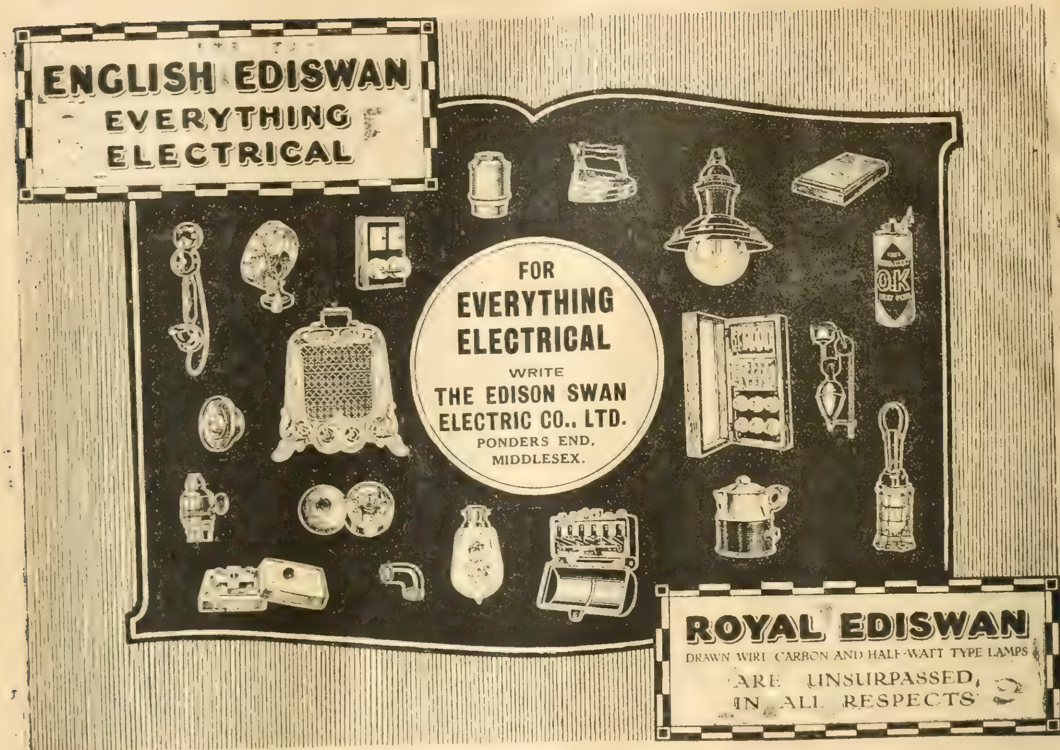

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COMMERCIAL & INDUSTRIAL SECTION.

British Magnetos for British Users.

All users of magnetos will be gratified to learn that as a result of co-operation on the part of the members of the British Ignition Apparatus Association, purchasers of magnetos made by them will enjoy the many advantages which arise from standardisation in production.

The complete magnetos are interchangeable not only with one another, but with the best-known pre-war types, for every one of which there are now one or more British magnetos of similar purpose and capacity. Further, many of the essential parts are standardised and interchangeable. Screws will be used of standard dimensions, and the different sizes of brushes are being standardised and reduced in number to one-tenth. Other parts are being dealt with in a similar way. This means, first, that spare parts will be much cheaper, and, secondly, that they will be easily and quickly procurable because agents and garage proprietors will be able to supply from stock. The advantages will be increased by the fact that certain firms are concentrating on particular types in order to secure the benefits which arise in efficiency and economy from quantity production. The following list of British standard types of magnetos for the motor trade shows the corresponding pre-war types, where such exist, and the number of British firms now making them :—

British standard type.	Size and purpose.	Pre-war type.	Now being made by.
M.1	1-cylinder light weight motor cycle ...	Z.A.1	4 British firms
M.2.	2-cylinder opposed motor cycle	Z.A.2	3 British firms
M.V.	2-cylinder V. light weight motor cycle	Z.A.V.	1 British firm
K.1.	1-cylinder standard 3½-4½ H.P. motor cycle.	Z.E.1	4 British firms
K.2.	2-cylinder V. 6-8 H.P. motor cycle ...	Z.E.V.	2 British firms
K.V.	2-cylinder (opposed) 6-8 H.P. motor cycle.	Z.E.2	2 British firms
G.4.	4-cylinder for light cars	Z.F.4	4 British firms
E.4.	4-cylinder for large cars and lorries ...	Z.U.4 R.4	5 British firms
E.6.	6-cylinder for cars and lorries	Z.R.6	4 British firms

All of the above types are being supplied in large quantities to the British and Allied Governments. In addition there are full ranges of standardised British magnetos for aero, stationary and marine engines, for agricultural work and for all kinds of gas engines.

* * * *

Alliance of Employers and Employed.

The Executive committee of the National Alliance of Employers and Employed has prepared a definite programme on specific matters of industrial organisation.

The aim of the Alliance is to promote active co-operation between employers and employed in labour questions, and to promote the welfare of the industrial workers as well as the efficiency of the industries. In its programme the Committee, while dealing with important questions such as the living wage and housing, desires to encourage workers to take an interest in the efficiency of their work, and to secure the adherence of trade unions to agreements. It is not intended at present to include Scotland, as it is considered that that country can be more successfully organised through an alliance of its own.

At a representative gathering of the National Alliance of Employers and Employed last week the above scheme for promoting improved relations between capital and labour was approved.

The constitution of the movement was decided upon, and a programme setting forth the broad aims of the Alliance adopted. Mr. Heath [illegible] [illegible]

* * * *

Empire Resources Development Committee.

[illegible]

Organisation of Commercial Intelligence.

The Commercial Committee of the House of Commons has recently issued a report approving of the proposals of the Government for establishing an enlarged Commercial Intelligence Department in connection with the Foreign Office and the Board of Trade.

The committee therefore welcome the establishment of the new and enlarged Commercial Intelligence Department as a step towards the establishment of an independent Ministry of Commerce directly responsible to Parliament alone.

It is considered that the Department should tend to secure greater co-operation and co-ordination than has hitherto existed between the two departments concerned, and that therefore it should be given a fair trial.

In addition to the collection and diffusion of commercial intelligence, the efforts of this new department should be directed towards the equally important subject of advising, assisting and supporting traders and business men in the acquisition, promotion and expansion of trade in foreign countries and in the Overseas Dominions.

The failure of the commercial side of the Foreign Office and the Commercial Intelligence Department of the Board of Trade to secure satisfactory results in the past has, in the opinion of the committee, been due to the commercial attachés, consular officers and trade commissioners having been chosen on account of their diplomatic training and experience rather than on account of their business knowledge. Nor do the Committee think that the salaries offered and the chances of promotion and a career held out to the candidates for these appointments have been sufficiently attractive to induce suitable business men with the necessary training and qualifications to apply for them.

The report also dealt with the selection and training of the necessary staff of the new department, and it is stated that "all the officials employed, whether at home or abroad, should [illegible] to promotion and the opening up to them of a satisfactory career if they are successful in their work." [illegible] mittee have been and still are in favour of the establishment of a separate Ministry of Commerce which should be directly responsible to Parliament and "master in its own house," and they believe that the ultimate solution of the present difficulties lies in that direction.

* * * *

An Indian Trade Bank.

It is proposed to establish an Indian trade bank, which will be known as the Tata Industrial Bank. The scheme has already received considerable local support.

The promoters (Messrs. Tata, Sons & Co.) [illegible] number of industrial [illegible] the Tata Hydro-Electric Power Supply Co., the Indian Cement Co., the Tata Mills (Ltd.), and the Andhra Valley Power Supply Co. [illegible] (100) premium.

* * * *

American Electrical Exports.

[illegible] metal filament and [illegible]

* * * *

Australian Commerce.

[illegible]

ELECTRICITY SUPPLY.

EXTENSIONS.

Dundee.—The question of the extension of the electricity works was considered by the Electricity Committee last week, when it was suggested that Major H. Richardson, the city electrical engineer, who is at present on active service, should be demobilised.

The CONVENER (Mr. Nairn) explained that the department could not take on any new consumers at present, and they would need another great extension of the works.

Mr. ANDERSON thought they should ask the demobilisation of Mr. Richardson. Valuable as his services were to the Army, he thought he would be more valuable at home.

Mr. CRICHTON pointed out that the manufacturers of generating machinery were getting full up with orders for after the war, and Dundee might have to wait for two or three years.

A Sub-Committee was appointed to consider the whole matter.

Ham.—Surrey County Council have authorised the Twickenham & Teddington Electric Supply Co. to lay a cable for the supply of a new factory at Ham.

Huddersfield.—It is proposed to raise a loan of £40,000 for extensions of the electricity generating plant and for laying cables to give supplies of power to several works.

Poplar (London).—On the advice of the engineer and manager (Mr. J. H. Bowden), the Electricity Committee has directed that tenders be invited for two additional 1,000 kw. converters, in order that contracts may be placed early enough to secure delivery in time for the winter load of 1918.

The estimated cost of the two converters is £8,000. One other rotary converter is also on order for the new High-street sub-station.

The Committee further report that an emergency has arisen owing to the burning out of a converter at the main station, throwing a dangerous over-load on the remaining converters. As it was urgently necessary that a converter should be obtained to replace the damaged machine, they authorised Mr. Bowden to endeavour to secure delivery of a B.T.-H. converter, which would provide one of the two additional converters required. The Committee also authorised the engineer to obtain a price from the Westminster Engineering Co. for re-winding the damaged converter.

GENERAL.

Board of Trade Electric Power Supply Committee.—At last week's meeting of Glasgow Corporation the Electricity Committee, reporting on the appointment by the Board of Trade of a committee to consider the steps to be taken to ensure an adequate and economical supply of electric power for all classes of consumers, recommended as follows:—

That the witnesses who might give evidence before the committee be authorised to state that if it is ultimately determined to divide the country into areas for generating electricity, and an area is created for Glasgow and the Clyde and places adjacent, the Corporation is prepared to become the generating authority for such area, provided the terms and conditions upon which they are required to do so will not be detrimental to the city and its existing electrical undertaking.

Mr. Kerr asked for an assurance that the Corporation would insist that they should be the generating authorities, and that they were not going to do anything that would allow the authority to pass into private hands.

The Lord Provost said the answer was in the affirmative.

The recommendations of the committee were adopted.

Electricity and National Welfare.—On Nov. 17 the first of a series of three Chadwick lectures on "Electricity and the Improvement of Town Atmospheres" was given at Leicester by Prof. H. T. [illegible]

The lecturer began by stating that the war has brought home to all thinking people the urgent need for national efficiency, which meant obtaining the best possible results for a given expenditure of wealth or effort. [illegible] the latest developments of electrical science [illegible] the cost of production. Recognising that a large part of [illegible] were [illegible] of labour and material. [illegible] matter from the air [illegible] in London and Leicester. After explaining some necessary electrical principles, the use of electricity was described when used as a [illegible] after formation. Reference was made to the experiments of Lodge and others, and details were given of the latest [illegible]

[illegible] After [illegible] supplied electrically with heat, light and power, he showed the urgent need for a system of power stations on a large scale, using very efficient generators, the cheapest fuel, the highest possible load factor, high voltage to obtain efficient distribution and interlinking between the stations to economise in spare machinery. Interesting comparisons were made as, for instance, between the power installed in the average very large town, having a population of some hundreds of thousands, for the purpose of distributing heat, light, power and traction to the community, and that supplied to a single fast liner. In the former case the horse-power will be usually well under 20,000, while in the case of a liner such as the "Mauretania," for mere propulsion at about 26 knots, some 68,000 H.P. is provided, while this could be lessened to 38,000 H.P. if the owners and passengers would be content with a speed of 20 knots. Statistics were quoted showing how urgent the coal problem will become in the future, and how inadequately it had been dealt with in the past. It was pointed out that exceedingly economical methods for obtaining electrical energy could be adopted in many places by using heat now running to waste in connection with other industrial processes.

The second lecture on "Electricity and Increased Food Production" will be given on the 24th inst., at 7.30 p.m. Further particulars of Chadwick Lectures may be obtained from the Secretary of the Chadwick Trust, 40 (6th), Queen Anne's-chambers, Westminster, S.W. 1.

Electricity Works and Publicity.—On Saturday last Mr. Howard Foulds, secretary of the City of Birmingham Electric Supply department, read a Paper before the local Electric Club on "Publicity."

Mr. Foulds stated that the engineers of whom the club was composed had their hands full at present with orders in connection with the war for either the War Office, the Admiralty, or the Ministry of Munitions. He felt, therefore, that they would not now contemplate any expenditure upon publicity intended to increase their business. Nevertheless, he pointed out that it was necessary to be prepared for the time when the present abnormal conditions would cease, and on those grounds he hoped the information he submitted would prove of value to them in any prospective publicity campaign they might individually or collectively undertake. He called attention to the various forms of publicity, and said that it was very necessary that any operations should be carefully thought out beforehand. Anything done should be persisted in for a reasonably long period, for persistency was one of the fundamentals of success.

Increased Charges for Electrical Energy.—The charges for current are being increased at the following places:—

Poplar (London) Council is making an advance of 15 per cent. for current for power and public lighting (making a total increase of 25 per cent. on pre-war rates), and 10 per cent. for private lighting and domestic supplies.

Lincoln Council is increasing its charges by 10 per cent. to all consumers other than those taking current for power under agreements, who are to be asked to agree to an increase of 5 per cent., in addition to the increased amount already paid under the sliding scale.

At Southampton the charges for current are being increased by 10 per cent., owing to the increase of 2s. 6d. per ton in the price of coal.

Woolwich Council is increasing its charges by 1½d. per unit for private lighting (other than factory lighting), ½d. per unit for power up to £200, and ⅜d. over £200 per annum.

Leigh.—The engineer and manager of the electricity works (Mr. A. T. Smith) has resigned in consequence of having accepted an appointment with British Dyes (Ltd.).

Nottingham.—In the "Nottingham Daily Express" of the 17th inst. there was a long letter by Mr. H. W. Cox, criticising the administration of the municipal electricity undertaking.

Mr. Cox states that he had prepared a table of costs which showed that as compared with the six English towns which are now producing about 14 million units of current per annum, the capital outlay of the Nottingham Electricity Department is 130 per cent. more than the average. They are, therefore, justified in thinking that they ought to have good machinery. A further table of comparison between the average of the 27 towns and Nottingham gave the following astounding results:—

Coal costs	63	per cent.	in excess
Oil and water	500	,,	,,
Wages	114	,,	,,
Repairs and maintenance	33	,,	,,
Rates and taxes	300	,,	,,
Management	83	,,	,,
Total working costs	97	,,	,,

Mr. Cox proceeds: To particularise—the coal in Nottingham costs more per unit than in all the 27 large English towns, Luton included. The same with water. The same wages. Now we come to the average [illegible] For private lighting Nottingham charges more than any of the 27 towns, with the exception of St. Pancras. The average charge of the 27 towns is 1·17d. per unit; Nottingham charges 2·19d. per unit, equal to 87 per cent. excess charge. To show how the high prices affect the consumption I may say that Nottingham sells 32 units per head of population per annum; the average of the 27 towns is 111 units per head, or a difference of 248 per cent. To further emphasise this I

will make a comparison between Nottingham and Luton in the years 1907, 1912 and 1917.

	1907.		1912.		1917.	
	Cost price.	Units generated.	Cost price.	Units generated.	Cost price.	Units generated.
Nottingham	0·98d.	9,500,000	1·02d.	12,500,000	1·34d.	14,750,000
Luton.........	0·98d.	686,000	0·75d.	3,000,000	0·59d.	14,250,000

The above figures indicate how low price of current increases sales thereof. In ten years Nottingham has increased output by 54 per cent., and Luton by 1,973 per cent. It will be noted that in 1907 the cost prices of the two towns was identical; five years later Luton was ahead of Nottingham by 33 per cent.; another five years and Luton was ahead of us by 127 per cent., and the output increased by even a larger percentage.

I will now put down in understandable figures the amount of money annually wasted in Nottingham through the incompetence of the Electricity Committee. We in Nottingham produced last year 14,717,442 units of current, and it cost us £81,894; the cost averaged from the 27 English towns would be £40,473 less; as compared with Luton (which is a long way from being the premier English town) the excess cost in Nottingham amounts to £45,992. Then we come to the selling prices. Now there are in Nottingham in round figures 3,000 consumers of electricity, and they have to pay £60,000 more per annum than the residents of Luton; £42,000 more than the average of the 27 English towns. Now I come to the amount which the rates benefit by these enormous charges. Luton and Nottingham produce practically the same amount of electricity. Luton makes a net profit of £5,025—Nottingham a net profit of £5,332. In other words, we make £307 more net profit than Luton, but to attain this wonderful end the ratepayers have to pay £60,000 more per annum for their current than the Luton folk do.

Walsall.—At the local Chamber of Commerce on Monday there was a discussion of the recent increase in the electricity charges.

On the proposition of Mr. W. M. Brookes (president), seconded by Mr. C. H. Gameson, a resolution was passed stating that the Chamber viewed the increase and the effect it must have upon the future trade of the town with apprehension, and assuring the Town Council of their support in any measures which might be taken to put the electricity undertaking upon a footing that it could compete with other forms of power.

Mr. Brookes gave details of the charges for electric current in other Midland towns to show that they were generally lower than at Walsall, and said if, as seemed likely, manufacturers could obtain cheaper forms of power they would withdraw their support from the electricity undertaking.

Mr. Gameson said firms which had been induced by promises of cheap motive power to make use of electricity were considering whether it would not pay them to lay down their own plant.

Wrexham.—The salary of the assistant electrical engineer (Mr. S. Thornton) has been increased by £52 a year.

Yarmouth.—The men employed at the electricity works have been granted an increase of [illegible] a week in their wages.

LIGHTING AND INDUSTRIAL POWER.

An Electric Threshing Machine.—For some time a portable threshing machine outfit, driven by an electric motor, has proved successful on a large farm in North Carolina. Electric current is supplied by the Durham Traction Co., and the installation consists of a 20 H.P. motor placed on skids and covered over in order to protect it from the weather. The skid mounting permits it to be moved to different portions of the farm, and placed near to the wheat or oats to be threshed.

Poor Law Institution Lighting.—The H[illegible]warden Guardians are recommended to adopt electric lighting at the workhouse in place of oil lamps.

The Chairman and they adjourned [illegible] and he thought it would involve an expenditure of [illegible].

Mr. [illegible] did not think it would cost [illegible]. It was a danger to the house to have the inmates going about with oil lamps.

It was eventually decided to open the two tenders received. One firm tendered to do the work for [illegible] and the other for [illegible]. It was, however, agreed to defer the matter in order to consult an electrical engineer.

Village Lighting.—At last week's meeting of the [illegible] Parish Council, Mr. C. F. M[illegible] attended and outlined a scheme for introducing electric lighting into the village.

Mr. M[illegible] [illegible]

[illegible] The Council decided to take time to consider the matter, but a hearty vote of thanks was accorded to Mr. M[illegible] for his [illegible].

ELECTRIC TRACTION.

Birmingham.—The Tramways Committee has decided not to run a tramcar service on Christmas Day.

Councillor Harrison Barrow has been re-elected chairman of the committee.

Board of Trade Tramways Committee.—The Executive Council of the Municipal Tramways Association has nominated the following three gentlemen to serve on the committee proposed to be appointed by the Board of Trade to deal with questions of tramway maintenance, labour, &c., during the war:—

Messrs. A. R. Fearnley, hon. secretary, the Municipal Tramways Association, J. B. Hamilton (Leeds) and J. M. M'Elroy (Manchester). The committee will consist of the three representatives nominated by the Municipal Tramways Association; Mr. A. L. C. Fell, representative of the London County Council Tramways; two members nominated by the Tramways and Light Railways Association, and the chairman (Mr. James Devonshire), nominated by the Board of Trade.

Christmas Tramway Traffic.—The Amalgamated Association of Tramway and Vehicle Workers are agitating for the general suspension of the tramway service throughout the kingdom on Christmas Day.

All tramway concerns in the country have been communicated with, replies in some cases being favourable and in many others unfavourable. The association intends to continue the agitation.

Dundee.—As the result of a discussion at a meeting of the Tramways Committee last week the present method of collecting fares is to be abolished, and a sub-committee has been appointed to devise a new ticket system, in order to prevent travelling without paying fares.

Grimsby.—A local firm has placed seven electric vehicles on the streets and has placed another seven on order.

The firm proposes to erect a garage near the power station to accommodate a large number of cars and where facilities for charging the batteries could be readily provided.

The Electricity Committee has also decided to lease a site near the works and to instal an additional "booster" at a cost of £152, capable of charging the batteries of three electric vehicles simultaneously.

Liverpool.—Ald. Russell Taylor has been re-elected chairman, and Ald. F. Smith as deputy chairman of the Tramways and Electric Lighting Committee.

Manchester.—The Tramways Committee recommend the shortening of the stages instead of increasing the fares.

About 620 yards will be knocked off the penny stage, and the other stages will be decreased accordingly. It is also recommended that the age for children's half fare be reduced from 16 years to 14 years.

The Committee have refused the application of the tramway workers for a general suspension of the services on Christmas Day.

Morecambe.—In returning thanks for his election as mayor last week, Ald. Wm. Wright said that one of the necessary improvement schemes was the adoption of mechanical traction on the tramways, while it was also desirable to extend the borough boundaries.

Women Tramcar Drivers.—About 16 municipal tramway undertakings now employ women drivers, and Glasgow Corporation have 220 of them.

The Highways Committee of the L.C.C., who have collected information on the subject, are considering [illegible].

Yarmouth.—At the meeting of the Corporation last week the surveyor reported that the [illegible] rails on the [illegible] needed repacking, the [illegible] and the cutting out of [illegible].

[illegible]

The report was then adopted.

TELEGRAPHY AND TELEPHONY.

Radio-Telegraphy in Brazil. The Government has opened a credit of 1,000 contos of reis (1,400,000 f.) to complete the work of establishing the new radio-telegraphic stations and increasing the telegraphic lines for the Army and Navy.

Radio-Telegraphy in Hong Kong.—The U.S.A. Consul at Hong Kong, Mr. A. E. Carleton, states that an installation for the radio station at the Royal Observatory, Hong Kong, is being constructed. The installation consists of a single triangular steel-lattice mast 150 ft. high. The aerial (which is on order in America) will spread from the mast to six chimney stacks of a terrace of houses 150 yds. to the south of the mast. The receiving apparatus consists of a receiving set by the British Telegraph Instrument Co., to be used in conjunction with a Brown relay and high-resistance telephone. At present the installation is to be used only for receiving time signals from Shanghai, Manila and Hanoi, and possibly from Tsingtau and one or more Japanese stations by night. After the war it is proposed to instal apparatus for distributing time signals by relay via the Cape d'Aguilar radio station. The Government hopes that arrangements may then be made for receiving meteorological observations from ships at stated times.

IMPERIAL NOTES.

Australasia.—The Victorian Railways Commissioners announced recently that, in order to secure an early start in electric traction on the suburban railways of Melbourne, and to ensure some advantage (if only a saving in interest on the large sum already invested in the enterprise) from the new system, it had been found necessary to place in the United States orders for certain materials which are urgently required and for which orders previously placed in Great Britain had had to be cancelled.

The Commissioners state that arrangements have been made to secure from America a relatively small portion of rotary converting plant, transformers and switchgear essential to the commencement of electric traction, that the order has been placed with the General Electric Co., the contractors for the electrical equipment of the suburban rolling stock, that the orders originally placed in Britain for this gear have been cancelled, and that a slight saving has been made, the American price being not much in excess of Mr. Merz's original estimate.

Canada. The Standing Committee for the purpose of promoting trade between the United Kingdom and Canada, appointed by the Winnipeg Board of Trade, will in future be known as the Empire Trade Committee.

Canadian Trade Corporation. The Senate has adopted the recommendations of a Special Senate Committee of the Dominion Parliament that a Canadian trade corporation should be established, similar to the British Trade Corporation recently organised in the United Kingdom.

FOREIGN NOTES.

Argentina. A company has been formed at Buenos Ayres under the title of La Electrica to operate electric power stations. The capital is $100,000 m/n (about £8,700), and Senor Enrique Piccaluga is president.

The contract with the Cia. Alemana Transatlantico de Electricidad expires in November, and the board endeavoured to obtain an arrangement with the company on more advantageous terms, but without success. They subsequently entered into a more favourable contract with the Cia. Italo-Argentina for 15 years. As the Italo-Argentine Co. [illegible] the capital, the tramway company [illegible] power station at Banfield to feed the section [illegible] and it had to lay cable [illegible] current [illegible]. The points at which current was taken would [illegible] cable would be shifted and [illegible] both in the Capital and in Avellaneda [illegible] appreciable economy in the consumption [illegible] about $200,000. Profit and loss account [illegible] 1,619.

[illegible] Compania de Tramways Electricos del Sud for the year ended [illegible] 30 [illegible] $1,05[illegible] compared with $1,121,982 in previous year, and [illegible] 8,709,120 passengers were carried. Working expenses [illegible] $1,001,372 ($959,181).

Chili. The British Consul-General at Valparaiso says the British [illegible] at Valparaiso has decided to form a British Chamber of Commerce in Chili for promoting British trade in that country.

Japan. The British Vice-Consul at Tokio (Mr. C. H. Phipps) [illegible] other notes on industrial progress in Japan.

[illegible] companies have been formed [illegible] of the war with a capital of about [illegible] [illegible] produced annually [illegible] and among them [illegible] have established new works. Three new steel companies have commenced operations and have established four new works. The total combined capital of these companies is estimated at 5,000,000 yen. Orders from China and India have been received, and one company will devote its energies to export trade. The future of the zinc industry is considered to be exceedingly good, and it is expected that a large export trade will be carried on after the war. One company is manufacturing zinc for the export trade. Five new companies, with a total combined capital of 7,600,000 yen, have been organised, and operate six works for the treatment of zinc ore produced in the country. A company, with a capital of 1,000,000 yen, was formed in March, 1916, for the purpose of producing aluminium. Alumina is obtained from a clay which is a special product of Japan, and is treated by an electrolytic process. A company was formed in January, 1917, with a capital of 100,000 yen for manufacturing sheet lead for use in chemical industries. A company, originally established in 1913, with a capital of 300,000 yen, and manufacturing g.i. sheets and wire, has increased its capital to 700,000 yen, and it intends to export its products later. For the manufacture of machinery, three new companies have been formed with a capital of 2,300,000 yen.

Six companies have been organised for the manufacture of electrical supplies and accessories, such as electric motors, dynamos, switches, lamp bulbs, carbon electrodes, carbon brushes, &c. An improved process for the manufacture of micanite has enabled a Japanese company to turn out insulators for home and export trade. The total combined capital of the six companies is 4,530,000 yen.

A company (2,000,000 yen) has been organised for the manufacture of imitation celluloid, which, it is claimed, besides serving the same purposes as celluloid, can also be used as a substitute for lacquer, artificial leather and rubber, and also as a water and heat resisting material in constructional work.

A company has been organised for the manufacture of concrete for re-inforced concrete buildings and telegraph poles.

MISCELLANEOUS.

Advertising Circulars.—The Royal Commission on Paper has authorised manufacturers, merchants, dealers and agents for sale to issue and despatch up to Jan. 31, 1918, trade catalogues and price lists relating to goods made or dealt in by them to any person who sells, or for the purpose of his trade or business uses, the goods referred to in such trade catalogues or price lists.

Alleged Receiving.—At the Central Criminal Court last week Simon Deitch, electrician, was found not guilty on a charge of receiving 53 boxes and 5,500 flash lamp bulbs.

Australian Copper.—The Australian Copper Producers' Association has been formed for the purpose of controlling the shipping and selling of copper on a co-operative basis.

E.C.C. Works Institute.—We have received a copy of the 1917-18 membership card of the Electric Construction Co.'s Works Institute, Wolverhampton.

The subscriptions payable by members, male or female, are 1s. and 6d. per quarter respectively for members over and under 18 years of age. There are no additional fees for the use of the lending library, or attendance at the physical culture and dancing classes, but small extra fees are payable for the use of tennis courts, bowling greens and billiard table.

Excess Profits Duty.—On the application of the Consolidated Rubber & Balata Estates (Ltd.), the Board of Referees has fixed the statutory percentage at 10 per cent. in the case of companies, and 10 per cent. plus 2 per cent. for accounting periods ending after Dec. 31, 1916, for other undertakings, for the business of collecting, preparing for sale and selling wild balata, the latex of certain forest trees in British Guiana.

Exports to China.—The "London Gazette" of Nov. 20 contains additions to the list of firms and persons in China to whom goods may be consigned.

These include the Chang Ma Electric Light & Power Co., Ltd. (Amoy).

Industrial Chemists and Metallurgists.—An association for chemists and metallurgists, entitled the National Association of Industrial Chemists, has been formed in order to advance the economic, intellectual, and social advancement of its members.

A general meeting of the Association will be held in Sheffield on Dec. 15, 1917, to appoint a National Council and institute local sections. Mr. E. J. Thackeray, Bailey-street, Sheffield, is secretary.

Prohibited Imports.—A Royal Proclamation was issued on Nov. 16 prohibiting as from that date the importation of various goods, including the following:

Abrasive wheels, brass rod and wire, electric meters, electric motors [illegible] electric hand lamps and torches, magnetos, measuring tapes and rules and micrometers.

Women in Industry.—A Women's Trade Union Advisory Committee, consisting of representatives of the trade unions which comprise women members, has been formed at the request of the Ministry of Munitions.

The Committee is analogous to the committee set up some months ago to advise on matters concerning men's work, and it is proposed to refer to it all questions affecting the employment of women on the production of munitions.

EDUCATIONAL.

University of Bristol. The donor of the buildings and land to this University is Mr. Henry H. Wills, and not Mr. H. Wells as stated in our issue for Oct. 26.

Liverpool University.—A legacy of £10,000 has been left to the university for the purpose of founding a Chair of Commerce.

Heriot Watt College, Edinburgh. In September the special committee which was appointed to consider and report upon the position of this College requested Prof. Darroch to draft a report for their consideration.

In the course of this report it is pointed out that the College does not at present adequately provide the education required for the training of the artisan, but only imperfectly provides the necessary training required by the technical expert.

Prof. Darroch advises that the function performed by the College be circumscribed and definitely limited. It must give up the omnibus deal of education and definitely restrict itself to technological and technical education. It should limit the provision to the higher stages of those particular trades which require either [illegible] specialised machinery or extensive laboratory accommodation for the efficient higher education of the artisan. Engineering, mining and the building trades are examples. In each of these a separate school or department should be established under an intelligent head, and under the direction of a special committee who have some expert knowledge of the industry in question. These technological schools or departments should be correlated with the work of the continuation schools on the one hand, and on the other with the particular department of the College which [illegible] at the production of the particular expert. In supplying the need of trade education in the higher stages the College must take cognisance in future of a wider field than Edinburgh and district. It should become the college for the East and South of Scotland. Each particular [illegible] department should be made the concern of the particular trade.

In a report on the development of the College, Principal Laurie advises more adequate arrangements for teaching in the more important skilled handicrafts in Edinburgh—engineering, building, printing and furniture making. Consideration is given to the question of the training of the technical expert. The development of technical chemistry will take an ever-increasing demand for pure alcohol for industrial purposes, and the Government, having to a great extent [illegible] the difficulties of manufacturers in this direction, will in the future doubtless help to stimulate such industries. It is, therefore, essential that in a city like Edinburgh the department of biology known as technical mycology should be fully represented in the technical college.

The Special Committee have approved of Prof. Darroch's report, and recommended the Board to grant them power to confer with the various bodies concerned as to the future of the College.

TENDERS INVITED.

Telegraph and Telephone Instruments, Battery Material, &c.

Tenders are invited up to Dec. 5 and 12, 1917, respectively, for the supply to the Postmaster-General's Department, State of WESTERN AUSTRALIA, of telegraph and telephone instruments and battery material (to schedule W.A. 583) and telephone switchboards (to schedule W.A. 582). Tender forms, specifications, &c., from the office of the High Commissioner for Australia, Australia House, Strand, W.C. 2. *See advertisement.*

Turbo-Alternator and Condensing Plant.

CARDIFF Corporation [illegible] by [illegible] for supply and erection of [illegible] Turbo-Alternator and [illegible] Condensing Plant [illegible], &c., from the City Electrical Engineer.

Railway Stores.

THE SOUTH INDIAN [illegible] RAILWAY CO. require tenders by 10 a.m. Dec. [illegible] for the supply of stores, including telegraph material, [illegible] copper wire, tools, wire, &c. [illegible]

Cooling Towers.

[illegible] Dec. 12, for the supply and erection of [illegible] cooling towers at [illegible] Mr. [illegible]

APPOINTMENTS VACANT AND FILLED.

Applications [illegible]

[illegible]

[illegible]

Oldham Corporation Electricity Committee require a shift engineer. Wages £2 10s. a week with 12s. war bonus. Applications to Mr. Fred L. Ogden, [illegible] engineer and manager, Greenhill Electricity Offices, Oldham, [illegible] 1. [illegible]

The Education Committee of the Borough of Swindon invite applications for the permanent appointment of head of the engineering department of the Technical Institute. Commencing salary £250 a year. Applications to the Principal, Mr. G. H. Burkhardt, M.Sc., by Dec. 8. *See advertisement.*

Applications are invited for the position of Principal of the Coventry Municipal Technical School. Commencing salary £600. Particulars from the secretary (Mr. Frederick Horner). Education Department, Council House, Coventry. Applications by Dec. 1.

Mr. Stanley Saunders, of Lincoln, has been appointed chief clerk of the Salford Corporation electricity works.

BUSINESS ITEMS.

Messrs. Duram, Ltd., have removed to Thanet House, 231-2, Strand, London, W.C. 2. Telephone: Central 3016-7-8; Telegrams: "Duramistic Estrand" London.

Messrs. A. Tamplin & Co., [illegible] have removed to 258, King's-road, Reading.

The Board of Trade has sanctioned the formation of a new company, with works in London and Liverpool, to be known as the British Barimar-Thermit Welding Co., to take up and exploit the thermit welding process.

The partnership between Percy Freeman, Thos. J. Sack, Richd. Geo. Whiffen and Geo. H. Hadder (trading as the Mica Mfg. Co.), Volta Works, [illegible] has been dissolved so far as concerns [illegible] Debts by P. Freeman, T. J. Sack and Geo. H. Hadder.

The partnership between Wm. Brown and Geo. Johnston Andrew (trading as Andrews & Co.), electrical and mechanical engineers, 40, West Campbell-street, Glasgow, has been dissolved. Debts by Mr. Andrews, who continues the business.

House Lighting Generator. Messrs. Chas. Bingham & Co., 11, Queen Victoria-street, London, E.C., offer a premium of [illegible] for a suitable design for a small generator for lighting detached house, to be driven by oil motor [illegible]

BANKRUPTCIES AND LIQUIDATIONS.

Claims against Wm. John [illegible], consulting engineer, 116, [illegible] road, Maida Vale, London, N.W., are to be sent by Nov. 28 to Mr. E. L. Hough, Bankruptcy-buildings, London, W.C.

First meetings of creditors and contributories of Best's Safety Lamps (Ltd.), Providence Works, Park-lane, Leeds, will be held on Nov. 23 at the O.R., 24, Bond-street, Leeds.

CATALOGUES, &c.

FOREIGN TRADE DEVELOPMENT.—From the electrical sales department of Messrs. Vickers, Ltd., Broadway, Westminster, S.W. 1, we have received a leaflet [illegible] illustrated and well printed pamphlet relating to [illegible] and rotary converters.

[illegible]

received a pamphlet [illegible]

[illegible]

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

AMALGAMATED WIRELESS (AUSTRALASIA) (LTD.).—The report for the half-year ended June 30 shows a profit of £2,913, against £4,692 for the corresponding half of 1916, and, with £5,564 brought forward, the sum available was £8,477. A dividend of 5 per cent. required £7,000, marine insurance £1,000, and £477 was carried forward.

AMAZON TELEGRAPH CO. (LTD.)—The gross revenue for the year ended June 30 was £72,144 and the working expenses were £31,539. After providing £1,616 for income tax, £182 for depreciation of investments, £12,812 for debenture interest, £10,113 for sinking fund and placing £8,000 to general reserve, the directors recommend payment of a dividend of 4 per cent. (less tax) on the share capital, leaving £7,187 to be carried forward.

CAPE ELECTRIC TRAMWAYS (LTD.)—The profit and loss account for the year ended June 30 shows a profit of £79,893, and after providing for debenture interest, redemption of debentures, and taking into account the balance brought forward, the net balance is £39,152. From this amount the reserve fund has been credited with 12,000, leaving £27,152. Out of this sum the directors recommend payment of a dividend of 5 per cent. on the ordinary share capital, absorbing £24,561, leaving £2,591. 3s. 9d. to be carried forward to next year. The tramways carried 23,752,016 passengers, earning £231,106, against 22,477,366 passengers and £212,791. 17s. 10d. in 1915-16. A satisfactory increase on the preceding year is shown both as regards the Cape Town and Port Elizabeth systems. The difficulties of obtaining supplies and the high prices of all materials, as well as increased war bonuses to the men, keep the cost of operation at a high level. In spite of these difficulties the profit shows a satisfactory increase of £6,225 over the previous year.

MONTE VIDEO TELEPHONE CO. (LTD.)—Mr. Chas. Lock, who presided over the ordinary general meeting on Monday, said that the results of the past year were quite satisfactory having regard to the difficult times through which they had been passing. Last year the property stood in the books at 180,923. This had been depreciated by £8,000 out of revenue this year, while additional capital outlay for new extensions, &c., amounted to only £3,649, so that the property now stood at £176,572. Investments at cost amounted to £99,929, against £72,011 last year. The increase was provided for mainly by the depreciation and reserve for renewal of plant, for which £17,000 had been appropriated. While they had over £99,000 of investments on July 31 last at the present moment that item amounted to £113,000, the increase being made entirely out of proceeds of current remittances received from the business. Taking the investments, stores and sundry debtors, all of which were readily realisable, they had a total fund of £155,581, against which they had on the other side of the balance-sheet sundry creditors, the amount required for payment of dividend, &c., totalling only £20,880, so that they had a balance of £134,701 of absolutely liquid assets, as against a total capital of £[illegible] [illegible] apart from the value of the property. That was a very strong position to be in financially. The reserve for renewal of plant, which last year stood at £54,000, amounted this year to £68,000. The subscriptions, rentals, &c., amounted to £78,402, against £72,000. The larger gross receipts were the result of an increase of 614 in the number of subscribers, and it was very fortunate that they had added to the number of their subscribers, because the taxation this year showed a substantial increase. The profit and loss account showed a balance of £26,323, against £25,985 in the previous year. Although there had been [illegible]

S. SMITH & SONS (MOTOR ACCESSORIES) (LTD.)

S. SMITH & SONS (MOTOR ACCESSORIES) (LTD.)—At the annual meeting last week the chairman (Mr. Samuel Smith) referred to the growth of the business, and pointed out that it had been built up out of a long-established concern engaged in the production of scientific instruments. Since the beginning of the war the board, besides considering the present, had had an eye to the future. The orders for instruments and accessories were increasing by leaps and bounds, and the board looked on the department as one which had come to stay. They had secured the services of engineers of proved ability, and had already acquired the important business and goodwill of one inventor and manufacturer, besides securing the services of the inventor as consulting engineer to the company. The company's premises had been considerably enlarged, and the plant was now capable of producing a larger output. They had acquired the patents for a dynamo, for which they held previously the sole selling rights; a complete range of electric lighting dynamos and starters had been produced and tested with most satisfactory results; and a new patent motor watch of extremely simple construction had also been introduced. With the special consent of the Ministry of Munitions they had also been able to produce models of improved design of all their leading accessories, so that their factories might be in a position to supply new and up-to-date products with as little delay as possible after the cessation of hostilities.

UNITED ELECTRIC TRAMWAYS CO. OF CARACAS (LTD.)—The report states that the local company has again declared a dividend absorbing their net profits for the year, which enables the directors to continue their policy of fully distributing the whole of the available net revenue. After adding balance from last year (£2,428), the disposable balance is £13,799, out of which the directors recommend payment of a dividend for the year at the rate of 7 per cent. (less tax), which will absorb £11,900, leaving £1,899 to be carried forward.

NEW COMPANIES.

AZ-NU ENGINEERING CO. (LTD.) (148,897.)—Private company. Reg. Nov. 15. Capital £12,000 in 10,000 preference and 2,000 ordinary shares of £1 each. Metal workers, manufacturers of aircraft and component parts thereof, manufacturers of electrical appliances and materials, motor and general engineers, &c. First directors are G. Baynes (chairman), A. E. Heath, C. L. S. Fouracres and A. Greenless. Secretary, C. L. Fouracres. Reg. office, 261, Church-road, Mitcham.

BLACKBURN PROPELLER CO. (LTD.) (148,004).—Private company. Reg. Nov. 2, capital £20,000 in £1 shares, aeroplane designers and contractors, propeller, motor and accessories manufacturers, &c. First directors are V. Lightman, R. Barrow-Sieree, R. Blackburn and S. Lightman. Reg. office: 86, Cross-street, Manchester.

FREDERICK GREENWOOD & SONS (LTD.) (148,872.)—Private company. Reg. Nov. 12. Capital £5,000 in £1 shares. To take over business carried on at Rochdale as Frederick Greenwood & Sons, and to carry on the business of textile machinists, manufacturers of electrical fittings and machinery, textile and general accessories, &c. First directors are L. Greenwood, H. Waterhouse, W. Waterhouse, and A. Taylor. Reg. office, Trafalgar Works, Trafalgar-street, Rochdale.

CITY NOTES.

ASSOCIATED FIRE ALARMS (LTD.).—The profit for the year ended June 30 was £272 and with £290 brought forward the total is £563, which will be carried forward.

BRITISH EVER-READY CO. (LTD.)—Dividends at the rate of 10 per cent. per annum on the preference and ordinary shares have been declared for the half year ended Sept. 30.

CASTNER KELLNER ALKALI CO. (LTD.)—The directors recommend a final dividend of 11 per cent., making 20 per cent. for the year ended Sept. 30.

CHLORIDE ELECTRICAL STORAGE CO. (LTD.)—An interim dividend of 5 per cent. (tax free) on the ordinary shares (the same rate as last year) has been declared.

COALITE (LTD.)—A circular has been issued to the shareholders, stating that an agreement has been concluded with Low Temperature Carbonisation (Ltd.) under which that company is appointed manager of the business of Coalite (Ltd.) for 10 years from October, 1917. The company will receive advances of £6,000 in each of the five years commencing on June 1, 1918. Such advances will be repayable only out of the net profits derivable by Coalite (Ltd.) from the sale of its rights and interests by Low Temperature Carbonisation (Ltd.). The Carbonisation Co. will be entitled to 40 per cent. of the net profits arising from the sale of the rights and interests of Coalite (Ltd.).

CONSOLIDATED SIGNAL CO. (LTD.)—The directors recommend a final dividend on the preference shares of 3 per cent., less tax, making, with the interim dividend, 6 per cent. per annum, and a dividend on the ordinary shares of 1s. per share, less tax, for the past year.

ELECTRIC CONSTRUCTION CO. (LTD.)—A dividend at the rate of 6 per cent. (less tax) has been declared on the ordinary shares in respect of the year ending March 31 next.

STOCK EXCHANGE NOTICE.—A further issue of £150,000 5 per cent. consolidated debenture stock of the *Melbourne Electric Supply Co. (Ltd.)* has been granted an official quotation.


Benjamin
Lighting Specialities
are in Universal Use
REG. TRADE MARK.
In the Dye Works.
THE Dye Industry has been, and still is, one of Britain's great opportunities of the war. The monopoly which Germany enjoyed in this branch of Industrial Science is, we believe, a thing of the past, and we hope an unknown quantity in the future. As in most other captured industries of any importance, that of dye making calls for an unrestricted application of energy and science on the part of its chief promoters and exponents in this country to counter-balance the natural facilities of manufacture enjoyed by our rivals in the pre-war era, and it is a matter for congratulation that this concentration of brains and activities has already been the means of notable achievements in the right direction.
Naturally, the utmost efficiency in all conditions pertaining to the successful production of the dyes is absolutely necessary, and one of the most important of these conditions is LIGHT.
Realising this, we evolved a special range of Well-Glass Fittings, which, in addition to being vapour and fume-proof, were of high illuminating efficiency, and the large numbers which are installed throughout the country prove in a definite manner their superiority.
Other Specialities include Shock-proof Hand-Lamps Reflector Fittings, Semi-Indirect Fittings, Industrial Signals, etc., etc.
There is a Benjamin Speciality for every class of Installation.
THE
BENJAMIN ELECTRIC, Ltd.
ROSEBERY AVENUE,
LONDON, E.C. 1.
BENJAMIN WELL-GLASS
FITTINGS are GAS-TIGHT
and VAPOUR - PROOF.

THE ROUND TABLE.

By "KVA."

ELECTRICAL QUERIES OF THE MOMENT.—Who will succeed Howard Foulds at Birmingham, and what will happen to F. L. Rawson?

* * * *

SPARKS FROM AN ELECTRICAL PHILOSOPHY.

Think electrically, not gaseously [illegible] will make you happy and thrifty. Think of the matches you'll save!

* * * *

Don't rush to meet Life in a 40 H.P. car; use an electric. You'll see more, be less jerky, and people will like you better. What's the use of speed anyway, except to wear out tyres, shake off nuts, break springs, knot up nerves and raise no end of a dust?

* * * *

Complaint is general that the gas supplied nowadays is not up to the average standard. It has undergone a meter-morphosis, says "The Star."

* * * *

Mr. Perren Maycock will be shocked at this attempt on the part of "Glover's Almanac" [illegible] to undo all his work on

behalf of "Switch Control." I hope this example is only a war-time expedient.

* * *

When I use the telephone on behalf of this [illegible] established in 1861, I sometimes despair of the value of publicity. In places where one would least expect it I am asked when I say "We are THE ELECTRICIAN," "The electrician of where?" "What electrician?" "Whose electrician?" "Oh, the electrician's newspaper!" "Whose electrician's newspaper?" Oh, hang up!

* * * *

The war has brought [illegible] as those produced upon the [illegible]. I was in the office of a power company [illegible] with [illegible] to a telephone [illegible] like this: "Certainly, [illegible] absolute [illegible] motors at the same time."

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN, November 20, 1880.]

MENLO PARK.—Mr. Edison is [illegible] tests of his electric light apparatus at Menlo Park. The [illegible] will be on a large scale, 7½ miles of [illegible] for the purpose.

AT LAST.—The South Metropolitan Gas Company is about to reduce the price of its gas to 2s. [illegible] per thousand cubic feet. We think the [illegible] petitor will creep in before [illegible]. The electric light will not be denied.

LIGHTING UNDERGROUND RAILWAYS.—A correspondent of the "Globe" points out with reference to the proposed adoption of the electric light in London railway tunnels that the shadows would put a stop to newspaper reading in the carriages. No doubt they would. What is wanted in the Underground Railway is the suppression of smoke, not the extinction of gas.

THE TELEPHONE AMONG THE INDIANS.—The United States Fish Commission has connected by telephone its salmon hatching stations at Baird, on the McCloud River, California, with the establishment for breeding the California trout, five miles further up the river, and the apparatus is now in thoroughly good working order. The Indians look on in blank amazement, and call the instrument "Klesch teen," or speaking spirit.—"Journal of the Telegraph."

MOTOR-CYCLE RESEARCH SCHEME.

It is announced that the Cycle and Motor-Cycle Manufacturers' and Traders' Union have decided to make grants of substantial sums to the University of Birmingham for promoting [illegible] research in relation to motor-cycles. Negotiations on the subject have been conducted between the Principal of the University (Sir Oliver Lodge) and Mr. Charles A. Hyde, president of the Union, and although the scheme has not been finally settled, the following is said to be common ground between the parties:

That the sums of money provided by the Cycle and Motor-Cycle Manufacturers' and Traders' Union shall be [illegible] by the [illegible] University as a temporary trust fund [illegible]

(a) For the provision of [illegible] for a specific research in motor-cycle [illegible], having special reference to details of [illegible] of engines. (b) The annual [illegible] graduate student investigator [illegible] for the consumption of material [illegible]. The results of the research [illegible] a year to the Union and [illegible] information by the workers [illegible].

The above [illegible] of the Government [illegible].

Madrid Underground Railway.—A [illegible] for the construction of an underground electric railway in Madrid [illegible] 22 miles long [illegible] 8,000,000 [illegible] construction [illegible] rolling stock. There will be nine stations.

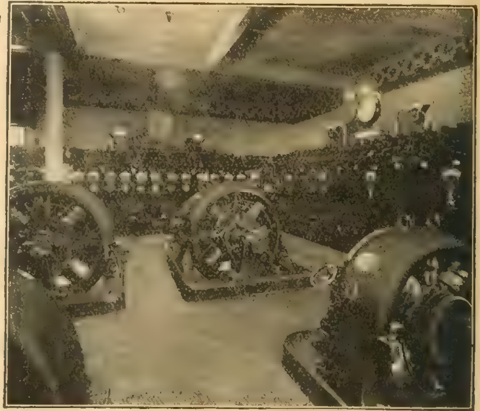
Customs Decision.—A [illegible] No. T. 801, [illegible] sanctioned the following interpretation of the Customs Tariff as regards electric fuses:

[illegible]

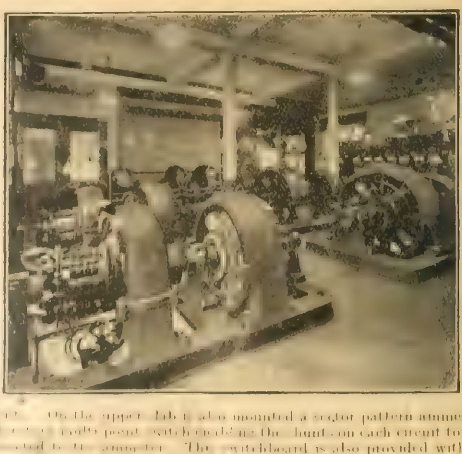
FACTORY ELECTRIFICATION.

For converting the 400-volt continuous-current supply of Manchester Corporation to the requirements of their central premises and warehouses in Withy Grove, Manchester, the Co-operative Wholesale Society have laid down a neat and attractive-looking sub-station containing the necessary converting machinery and distributing switchboard. Power from this sub-station is utilised for driving lifts, hoists, &c., and for lighting. The contract for the plant was placed with the General Electric Co. and includes four 90 kw. motors for driving existing generators, two 63 kw. motor-generators and one 47·5 kw. motor for driving an existing generator. These sets run respectively at 410, 600 and 300 revs. per min., the motors and generators being mounted on combination bed-plates.

The switchboard, which is an excellent illustration of modern practice, is arranged in two portions at right angles to each other. That portion



of the board devoted to the control of the motor-generators consists of eight panels, seven for the machines and one for the incoming supply. Each panel accommodates the necessary apparatus for starting the motors, which apparatus is mounted on the lower slab of the panel, while on the slab above are included the necessary circuit-breakers, ammeters, relays and shunt regulating gear. As will be seen from Fig. 1, where the motor generator controlling switchboard is to be observed in the background, paralleling voltmeters are carried on brackets at the end of the board, while on a pediment on the top of the board are mounted an illuminated dial sector pattern ammeter and voltmeter. The distribution switchboard, which is seen in Fig. 2, comprises 16 panels, each of which controls six distributing circuits. Every panel is composed of two slabs both carrying the circuit-breakers for the respective three

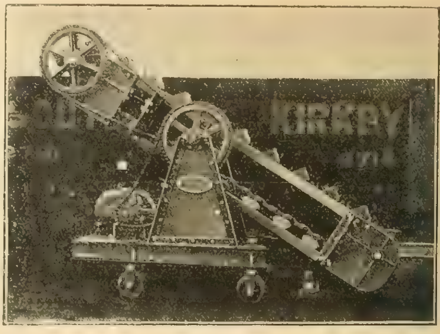


[illegible]. On the upper slab is also mounted a sector pattern ammeter [illegible] point switch enabling the [illegible] on each circuit to be connected to the ammeter. The switchboard is also provided with a [illegible] sector type ammeter and voltmeter and a non [illegible]. The lighting is effected by G.E.C. semi-direct fittings. The [illegible] equipment was supplied by the General Electric Co., of Withy Grove, [illegible] through their office at Victoria Bridge, Manchester.

We are indebted to the Co-operative Wholesale Society for permission to [illegible] the accompanying illustrations.

THE USES OF PORTABLE ELEVATORS.

Many industrial processes involving the handling or transport of materials could be performed with greater speed and efficiency and with a large saving in labour, but in many of these cases the installation of a fixed or elaborate conveying system would not be practicable or justifiable, owing to the changing venue of operation, or the irregular, possibly infrequent, and not always calculable periods when its use would be required. Such conditions are admirably met by the use of portable elevators or conveyors. They can be brought into use as and when required; they can be moved from place to place with the greatest ease, and they can be arranged so that the work of loading and unloading can be carried out by merely reversing the running. A small "Bennis" portable coal elevator of this type is shown in the accompanying illustration. It is 10 ft. long between the centres of the drums, and has buckets 8 in. wide.



The framework of the elevator consists of rolled steel channels and angles braced together. The top and bottom of the elevator is formed out of c.i. plates. The bearings for the shafts are cast on the plates, and the whole is bolted together to form a self-contained structure. The elevator is mounted on a portable truck in such a manner that the angle of the elevator can be altered if desired. The truck is built out of mild steel sections and is carried on four rollers. All the rollers are attached to pivoted axles. The top of the axle is made with a square so that it can be turned roundwith a spanner, and provision is made for locking the wheels in four positions. The axles work independently of each other. The elevator is driven by two chain drives. Two sprocket wheels are placed on the pivot shaft. One of these sprockets is driven direct from the motor, and the other sprocket drives the elevator shaft, so that the relative centres of the shafts are maintained irrespective of the angle of the elevator. When in operation the elevator is pushed up to the coal heap, and the coal trimmed forward to the buckets.

LABOUR SAVING BY LARGE UNIT STOKERS.

At least three firemen per shift, or nine men daily, are required for a battery of six large Lancashire boilers for commercial load of 4,000 gallons hourly evaporation. Six small water-tube boilers, set on the ground level, involve the same labour cost for same duty. But no manual labour whatever is involved in taking the same continuous load of 4,000 gallons hourly on a 12-retort Erith-Riley stoker. This large British-built stoker, being assembled from 12

standardised and self cleaning units, and fitted to a single archless and undivided furnace of a water-tube boiler, has easy capacity for evaporating 4,000 gallons hourly (day and night), with continuous automatic working, the ash being discharged in a steady stream at the rear of the boiler-furnace.

Erith-Riley stokers were first started two years ago in British central stations, and we are informed that they are now installed under all makes and types of boilers, including land and marine types, and are available without any limit of capacity to suit the largest boilers made or proposed, owing to their being assembled from self-cleaning retort units. Three years ago the eight-retort size was the largest in use of the corresponding American-made Riley stokers, but two years ago 16-retort stokers were put into use, and now the latest order is for six high-duty pattern 16-retort stokers, each having 33 per cent. more capacity than the standard pattern. No matter how large the stoker, it works without any manual labour, and there are no perishable brick arches to maintain. The 12-retort stoker weighs 24 tons, and its width is 20 ft.; all other sizes are in proportion.

The makers (Erith's Engineering Co., Ltd., 70, Gracechurch-street, London, E.C.) have already executed many repeat orders, and they have every facility for rapid production of this fully standardised stoker to suit all sizes and all makes of water-tube boilers.

WOMEN AS ELECTRIC TAXICAB DRIVERS.

Owing to the growing shortage of men, women are being employed by the Detroit Taxicab and Transfer Co., of Detroit, to operate their electric taxicabs.

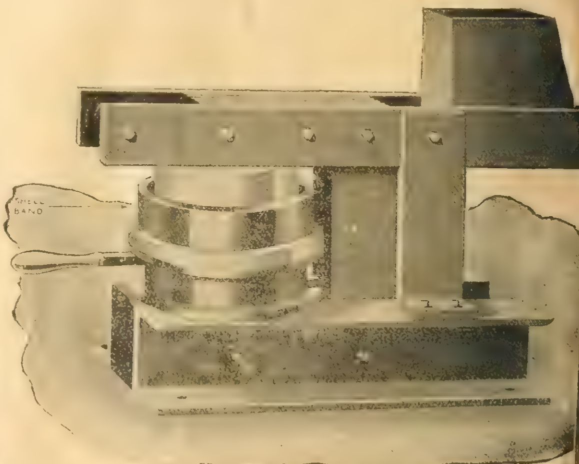
Feminine drivers are only employed during the day (between 7 a.m. and 6 p.m.), and they receive the same wages as the men. The driver of an "electric" needs only a few hours' training to become thoroughly competent, as owing to the simplicity of its mechanism and consequent infrequent disorders and repairs, the electric vehicle is easy to operate. The company had over 500 applications by women for chauffeur's positions, and several are already operating electric taxicabs with great success. The electric taxicabs of Detroit have enjoyed continued success for three years, and the company has now nearly 100 cars.

Chicago is also the home of a prosperous fleet of electric taxicabs. Twelve cars were put into service in April to supplement 20 petrol cars, but the "electrics" have practically displaced the gas cabs, as patrons constantly request them. St. Louis likewise has its fleet of successful electric taxicabs. In addition to other advantages, the cost of operating electric taxicabs is about half that of the petrol type.

SHELL-BAND HEATING TRANSFORMER.

Messrs. Johnson & Phillips, Ltd., of Charlton, S.E. 7, in their patent No. 7,187, of 1916, have developed an interesting application of the transformer for the heating of copper shell bands. The core and primary windings of the transformer (which is shown in the accompanying illustration) are arranged so that the copper shell-band slips over them and itself forms a short circuited secondary. It is designed for heating bands for 6 in., 8 in., 9·2 in., 12 in. and 13·5 in. shells, and the primary is wound for any voltage up to 550 and for 25, 40 or 50-cycle supply.

The capacity of the outfit is from 200 to 400 bands a day. The method of operation is as follows: A counter-balanced arm which forms part of the magnetic field and rests on the upper end of the core, is raised in order to allow of the band being slipped over the coil; the arm is then lowered and the switch closed. The band will be heated to the correct



temperature in from 1 to 1½ minutes, according to its size. As soon as the required temperature has been reached the circuit is opened and the band removed by means of tongs. The following advantages over gas or other heating systems are claimed for the apparatus: It can be placed in any convenient position, such as the framework of a press; it ensures even and uniform heating; no scale is formed on the band; there is no loss of bands through burning, no smoke, flame or fumes; it is easily and quickly manipulated, and it is as safe from fire risk as an electric motor.

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[illegible]

CONTENTS.

NOTES.

The Fixation of Nitrogen.

THERE are many who have regarded it as a reproach to this country that nothing has so far been done in the fixation of nitrogen, and that we should depend still upon by-product ammonia and upon imports of Chili nitrate to meet our needs. It is, therefore, of more than usual interest, particularly after the recent publication of reports on the subject in the United States, to learn that definite action has been taken by the Government, and that the subject has by no means been neglected. From a statement issued by the Government we learn that all the aspects of the nitrogen problem have been under consideration since the beginning of last year when it was decided to set up the Nitrogen Products Committee. The work of this Committee has been heavy owing to the fact that data in regard to many of the processes are not easily obtainable and to some extent are only in German hands. Nevertheless sufficient progress has been made to enable the Committee to present an interim report, which was submitted to the Minister of Munitions in February of this year. It appears that the Committee in this report recommends [illegible] factory having an annual output of about [illegible] tons of [illegible]. An Executive Committee has been formed and a scheme [illegible] power station [illegible] Minister. [illegible]

Validity of Contracts in Time of War.

IN an earlier stage of the litigation, we referred some time ago to the contract between the Metropolitan Water Board and Messrs. Dick, Kerr & Co., which has now been before the House of Lords. This contract was made in July, 1914, and involved large works which were to be completed within a period of six years. Owing to the outbreak of war the Ministry of Munitions in 1916 required the contractors to cease work, and a similar notice was served on the Metropolitan Water Board. At this time a substantial amount of work had been done under the contract. As is usual in such cases, the contract included a clause permitting extension of time for completion of the work if, in the opinion of the engineer, the work had been impeded by circumstances beyond the control of the contractors. Consequently the Metropolitan Water Board sought to maintain that the contract was not terminated, but that in effect an extension of time had been given for completion. Very naturally the contractors objected to any such interpretation of the position. In giving judgment the LORD CHANCELLOR pointed out that this was not a case of short and temporary stoppage of work, but of a prohibition by the Government. The clause in the contract did not cover the case which had arisen, for the circumstances could not possibly have been in the contemplation of the parties to the contract when it was made. Moreover, the interruption was of such a character and duration as vitally and fundamentally to change the conditions of the contract. We think it must be clear to all fair-minded people that the whole character of such a contract might be revolutionised by indefinite delay, and that by the time work could be resumed the cost of labour and material might be entirely different from that which was originally contemplated. We do not doubt, therefore, that this final judgment in the House of Lords will be received with satisfaction.

The Inventive Mind.

A SECTION of MR. A. A. CAMPBELL SWINTON'S address before the Royal Society of Arts on November 21st dealt with a question which has often been the subject of comment—the frequency with which great inventions have been made by men in fields quite different from their ordinary vocations. The cases of JAMES WATT, [illegible] STEPHENSON, ARKWRIGHT, Lord ARMSTRONG and others [illegible] [illegible]

may in early life have been working in occupations far removed from those in which their great achievements were made, yet these achievements followed prolonged and patient study of a highly specialised kind. Nor at the time their discoveries were made could CAVENDISH, ARMSTRONG and others be regarded as "amateurs," except in a very limited sense. On the contrary, they had devoted years to absorbing study, and were already far in advance of most of the other scientists of their time. Similar considerations apply to the careers of EDISON and others who were self-trained, and rose from a humble origin. In such cases the native genius of the man triumphed over educational difficulties, but the basis of scientific and specialised knowledge had to be provided before the period of invention in any particular field arrived. Another fact that needs to be borne in mind is the greater complexity in scientific knowledge at the present day. Cases of great discoveries by outsiders are now comparatively rare. Finally, it must be remembered that while a genius can and does come to the front in spite of all obstacles, the average mind is helpless without educational assistance, and in the future a more widespread scientific knowledge among the rank and file, and a capacity to experiment under direction, will be of vital consequence. There is therefore no reason to draw from these outstanding examples the conclusion that the provision of educational facilities is not needed; on the contrary, opportunities for scientific training were never more necessary than they are to day.

The Mineral and Oil Resources of the Empire.

In this issue we refer to two of a series of interesting lectures that are being delivered before the London School of Economics on "The Empire: its Commerce and Commercial Requirements." Prof. J. S. S. BRAME recently dealt with the subject of mineral oil, while Mr. SYDNEY JOHNSTONE, on November 16th, gave an address on the rarer key-minerals. As regards mineral oils the British Empire at present does not furnish more than about 3 per cent. of the world's production, by far the larger proportion of this amount coming from Burma. Even this relatively small proportion is naturally of great value in times like the present. But there is every inducement to search for new sources of supply, and the very wide distribution of oil, though limited in quantities, within the Empire offers hope that in course of time new and larger fields may be opened. Meantime it is interesting to note that in the tar sands of Athabasca, which cover an area of 2,000 square miles, we have a source of great possible future value, as soon as this area is more fully opened up and better transport facilities are provided. According to Prof. BRAME there are latent in these sands enough oil to provide the world at the present rate of consumption with supplies for nearly 2,000 years.

The Rarer "Key-Metals."

In the matter of the rarer key-metals the position is different. Within the British Empire most of these materials, such as tungsten, molybdenum, thorium and cerium, vanadium, [illegible], &c., occur, not only in many different localities but in considerable quantities, and in many cases the ores are now being worked with considerable success. The Empire, for example, is stated to be providing [illegible] per cent. of the world's tungsten. This metal is also being worked within the United Kingdom, whereas its extraction was scarcely attempted before the war. Molybdenum, which like tungsten is a most valuable ingredient in special steels, also occurs in different countries, and in the extraction of this material the United Kingdom appears to hold a very strong position. The chief exception in the list of available metals is platinum, which up to the present has been derived mainly from Russia and Colombia. But even in this case the lecturer held out hope that Canada might ultimately come to the rescue. When so much is being said on the need for research and the lack of enterprise that has characterised some British industries in the past it is encouraging to note these new developments. We have sometimes wished that a little more could be said of the successes of British enterprise since the outbreak of war, instead of dwelling so much on its failures in the past.

B.E.A.M.A.—Mr. C. H. Wordingham, president of the Institution of Electrical Engineers, has accepted office as one of the vice-presidents of the British Electrical and Allied Manufacturers' Association.

Institution of Electrical Engineers.—At the meeting of the Institution of Electrical Engineers on Nov. 22 the president announced that Prof. A. Righi, of Bologna University, had been elected an honorary member of the Institution.

Institute of Metals.—The eighth annual May lecture before the Institute of Metals will be given next spring by the Hon. Sir Charles Parsons, K.C.B., F.R.S., who will deal with the subject of the formation of diamonds. For over 30 years he has been experimenting upon the production of artificial diamonds. An account of his researches, which have an important bearing on many branches of applied science, will therefore be of great interest.

Telephone Time Service in Switzerland.—In Switzerland the complete suspension of private wireless installations at the outbreak of war caused considerable inconvenience to the watch and clock industry, which was accustomed to take its time from the wireless time-signals issued from the Eiffel Tower. The difficulty appears to have been overcome by an automatic apparatus installed at Berne, which receives the wireless time signal and conveys it by telephone to those who so desire. It is said that the telephone transmission has proved quite successful, accidental errors in transmission being rarely more than one-tenth of a second.

Resisting Chemical Glassware.—A recent number of the "Journal of the Society of Glass Technology" contains an exhaustive paper by Messrs. J. D. Cawood, S. English and W. E. S. Turner, on the "Attack of Chemical Reagents on Glass Surfaces." A variety of tests are described and Mr. C. J. Peddle, in opening the discussion, placed them in the following order of importance: (*a*) Water tests, (*b*) alkali and acid tests, and (*c*) cracking tests. Tests carried out on the six best glasses available, which included all the British glasses on the market, showed that these varieties were superior to the Jena glass. The British glasses now available are, therefore, not merely substitutes for, but actually in chemical resisting power supérior to, the previous German best.

Operation of Ice Plant Motors at Constant Load.—The advantages of the exact control of machinery permitted by the use of electric power are demonstrated in the case of the Greater New York Ice Co.'s plant, which receives energy from the Edison Electric Illuminating Co. of Brooklyn. According to the "Electrical World," this ice company pays for energy on a maximum demand rate. It has accordingly been taken to operate its machines on the basis of power input, keeping that constant and varying other factors to meet the changes in operating conditions. Variations in the power curve, therefore, point directly to unsuspected troubles—hot bearings, &c.—which are immediately remedied. This plant is operated at a very high efficiency, 250 tons (227 t.) of ice being produced in 24 hours by 350 H.P. in motors operating the compressors. At the same time the cost for the energy consumed is a minimum.

Science in Examinations for the Civil Service.—A memorandum issued by the Committee on the Neglect of Science recalls that in the last report, issued in July, mention was made of the Committee appointed by H.M. Treasury to consider the scheme of examination for Class I. in the Civil Service. The report of the Civil Service Commissioner (Mr.

Stanley Leathes) has recently been published, and the memorandum speaks with approval of its main conclusions, which are designed to provide adequate recognition of science and "equal opportunity" for all subjects. Thus, classics will in future have no advantage over the natural sciences in such examinations. The memorandum, however, remarks that the report stops short at "permissive legislation"—*i.e.*, it removes to some extent the barriers hitherto imposed on science, but it does nothing to compel the managers of the great public schools and universities to adopt a more intelligent scheme of education.

The Preservation of Wooden Poles.—The tendency to decay of wooden poles supporting aerial lines is a matter that may often require close attention in remote districts, where a very extensive area is covered, and periodic inspection is not very easy to carry out. In general, it appears, the unexpected failing of wooden poles is due to internal decay caused by certain micro-organisms which affect the wood. In an article in the "Electrical World" Mr. H. W. Meyer gives the results of experience based on the inspection of a system in Minneapolis comprising 20,000 poles, and describes various methods of treating the wood with hot creosote so as to destroy the micro-organisms responsible for its decay. Treatment takes the form of immersion in a tank, or the solution may be applied with a brush. The former method is naturally the more thorough, and as the extra cost is estimated to be only 5 per cent., the expense seems well worth while. It is stated that poles treated in an open tank may last twice as long as those merely treated with a brush, but even the brush treatment has the effect of lengthening the life of the pole by about a third.

Permanent Memorial to Women's Work on Engineering Munitions.—It is part of the scope of the Women's Section of the National War Museum that it should contain a permanent collection of engineering exhibits, illustrating the proficiency attained by women in work of an engineering nature in connection with the manufacture of munitions of war. The range of women's work on munitions and on other engineering work necessary to the war [illegible] that a special committee has been formed to undertake the work of collecting suitable specimens, and firms are invited to assist this Committee by submitting particulars of such examples as they would be willing to present to the National War Museum.

The collection is only intended to illustrate the nature of work which women have undertaken since, and [illegible] the war; and it will include details of aero engines, [illegible] and other engines, motor vehicles, machine tools, guns, [illegible] projectiles, gauges, cutters and small tools, gun sights and [illegible] within the limitation mentioned. The name and [illegible] of the firm giving the specimen may be recorded in [illegible] by the Committee, either on the specimens or on the [illegible] them. It is hoped that firms employing women on [illegible] work in connection with the making of war material will [illegible] which will constitute a permanent [illegible] of the work women have done in the war. Communications should be addressed to the hon. secretary of the Women's Work [illegible] Committee, National War Museum, 9 Queen Anne's-gate, London, S.W. 1. It is not desired that samples should be sent in the first [illegible].

Protection of Central Stations Against Short-circuits.—In a recent article in the "[illegible] de l'Electricité" F. [illegible] refers to some experiences of short-circuits in various electrical installations in [illegible], which [illegible] to the rapid and [illegible] of that region. [illegible] due to [illegible] [illegible] [illegible] [illegible] breakers [illegible] [illegible] [illegible] [illegible] and are therefore [illegible] of the current when an alternator is short-circuited is [illegible] limited by the impedance of the [illegible] and may be 10 or 30 times the normal current [illegible] [illegible] [illegible] proposed are: (1) The division of the vital parts of the station into independent groups of machines; (2) the diminution of the apparent power by improving the power factor of the system; (3) the limitations of short circuit currents by placing reactances in the circuits. Attention may also be given to the prevention of short circuits by reinforcing the stability of [illegible] with in practice, owing to the very variable resisting power of insulators or connections to violent short circuits. The author also suggests that the oil circuit-breaker is still an imperfect form of apparatus, that great vigilance is necessary in the supervision of breakers of this kind, and that they should always be placed in such positions as to minimise the results of accidents.

OBITUARY.

DEATHS ON ACTIVE SERVICE.—The following deaths on active service are reported:—

Pte. Joe Shaw (King's Liverpool Regt.), aged 23, who has been reported killed, was formerly employed by Messrs. Dick, Kerr & Co.

Gunner Wm. Wilkinson (R.F.A.), aged 27, formerly a Burnley tramcar driver, is also reported killed.

Acting Petty-Officer David Robertson (R.N.D.), aged 23, who was killed in action on Oct. 26, had served an apprenticeship as an electrical engineer at the Montrose Electricity Works, and was in the employ of Falkirk Corporation prior to the war.

PERSONAL.

Mr. Walter Allnutt, P.S.A.A., who has for many years held the post of secretary of Callender's Cable & Construction Co., Ltd., and the Anchor Cable Co., Ltd., has, in consequence of his advanced age and the necessity for obtaining greater leisure, requested the directors of those Companies to release him from his engagement with them. The directors have acceded to his request, and have appointed Mr. Howard Foulds, who is at present secretary of the Electric Supply Committee of the Birmingham City Council, to fill the vacancy thus occasioned. Mr. Foulds will commence his duties as secretary of the above Companies on Jan. 1, 1918.

On Nov. 9 Mr. H. Faraday Proctor celebrated his 25th year of service as engineer and general manager to the electricity department of the Bristol Corporation.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, Nov. 30th (to day)

INSTITUTION OF MECHANICAL ENGINEERS.

6 p.m. At the Institution, [illegible], London, S.W. [illegible] Engines. [illegible]

[illegible]

[illegible] p.m. At [illegible], London, S.W. Paper [illegible]

MONDAY, Dec. 3rd.

[illegible]

[illegible]

TUESDAY, Dec. 4th

[illegible]

WEDNESDAY, Dec. 5th

[illegible]

THURSDAY, Dec. 6th

[illegible]

Large [illegible]

[illegible]

MR. C. J. BEAVER'S ADDRESS TO THE MANCHESTER LOCAL SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.*

The conditions of war which are, unfortunately, still with us, have wrought kaleidoscopic changes in the world's industry. In our country the marvellous creation and development of our fighting forces has been fairly paralleled by our industrial mobilisation and the response of industry. This response has been made by no body of men more readily or efficiently than professional and industrial engineers.

Although the industrial machine has been hampered by many things and in divers ways, the mobility and adaptability of the whole has furnished a demonstration of our country's industrial potentiality which augurs well for the strenuous years ahead. Manufacturers' and Traders' Associations recognise that only by combination in comprehensive schemes of federation, embracing every fundamental feature from education onwards, can they wield sufficient influence in national and international affairs to do their part in ensuring the industrial supremacy of our Empire.

The engineering institutions and other scientific bodies perceive clearly that the maximum benefit to the nation from their functions and activities is obtainable only by co-operation with the Federated Associations, Advisory Councils and other bodies which the necessities of the times have called into being.

The Imperial Government recognising that the assistance which they formerly gave to scientific research and its industrial application was inadequate to meet the conditions revealed by the effects of war, have hastened to make good the deficit.

Among other points now receiving attention are the insistence on a knowledge of industry and scientific training on the part of those in Government Departments administering industrial matters, the reform in status and composition of Advisory Councils and Committees attached to Government Departments, and the reform of the Patent Laws.

Recently Sir Robert Hadfield and others have strongly advocated an Empire patent system with uniform practice and conditions regarding such matters as period of protection, fees payable by the inventor, and so on. This is extremely desirable, and, so far as a layman can see, should not be outside the realms of possibility. Educational reforms, especially such as relate to the higher scientific training in our technical colleges and universities, have been closely considered and fully discussed of late.

Assuming that the ultimate object of education should be to train and guide the development of the inherent mental capabilities of the individual to the good of mankind, it would appear to be sheer illogical conservatism to utilise the classics to that end, and to neglect the sciences. In these times of stress, however, there is a danger of taking an unbalanced view.

While urging reforms, therefore, I would also plead for the avoidance of revolution. Classical education is as necessary to the development of civilisation as scientific; and without the humanities—without the literary and artistic aspects of life—the wheels of progress must be like the wheels of the Juggernaut car.

As regards general education, however, time formerly given to classical studies should be encroached on for science subjects. In public schools facilities for scientific training should be greatly augmented and scientific subjects given due prominence. In fact, scientific knowledge should gradually come to be regarded as part of the intellectual equipment of an educated man, and become reflected in the habits of thought of every citizen, independently of any tangible application of science in his daily round.

There are two outstanding points which I should like to emphasise: firstly, the desirability of making greater use of post-graduate courses where these already exist, and providing them where they are not, [illegible]

[illegible]

the economical utilisation of fuel obviously claims first attention. Matters relating to the classification of coals, carbonisation and gasification processes, and other treatment bearing on the recovery and economical use of the various resultant products are being handled by the Fuel Research Board.

With regard to the generation and distribution of power, considerable steps have been taken in the direction of making the most efficient use of existing power plants, and a general linking up scheme has been propounded whereby the power requirements of the country may be served by about 16 systems instead of something like 600. Recommendations of a far reaching and more or less concrete character have been made dealing with such matters as the most economical sizes of generating stations and units of plant, and the most efficient transmission voltages.

The whole subject from winning the coal to distributing the power has called for the co-operation under Government auspices, of mining, chemical and electrical experts as well as the organised support of the various scientific and engineering bodies.

Conditions resultant on the war have sharply enforced on our notice the truth of the forecasts of that far-seeing scientist, Sir William Crookes, relating to the effect of the depletion and unfavourable distribution of the world's stock of natural fertilisers on its food supply, and the result has been an access of interest in electrical processes for the fixation of nitrogen.

The electrical stimulation of plant growth has also been brought to the fore, and although for various obvious reasons it has made little headway during the past 20 years, there is probably a fairly wide future before it.

The next necessity of those which I enumerated a few moments ago—the linking up of science and industry—is one which is of particular interest to us as an Institution. A broad survey of the industrial field shows that the relationship between science and industry is much closer in some industries than in others; and again in various branches of a given industry the breadth of the dividing gulf varies.

Perhaps the best case one can take as an illustration is the chemical industry. Its relation to pure science is perhaps more direct and less complicated than in any other industry comparable with it in magnitude and scope, and yet in some parts of it the gulf is both wide and deep. Its branches vary from, say, the manufacture of definite chemical substances, for instance, fine chemicals, dyes, optical glass, explosives, &c., to manufactures in which, although definite chemical processes are involved, the products have an indefinite chemical composition, such as textile, paper, leather, and ceramic goods.

In some cases there is little difference between laboratory and commercial scale operations. In others the operations are often of the crudest description, and the degree of control very meagre. The electrical industry—having the advantage of being comparatively modern—has, broadly speaking, its foundation in scientific research, and its general structure largely built up on industrial research.

There are, however, many other important industries which have been very largely built up on an empirical basis, and in addition subdivided so that their components and products pass through several isolated branches of those industries before they are completed. They may even for economic reasons have to go out of the country for certain processes to be performed in the course of their production. The cotton industries and some chemical manufacturing processes furnish instances of this. It is therefore clear that various grades of treatment are demanded.

We may regard scientific research as the pure scientific work carried out by physicists and scientists with the sole object of extending the bounds of scientific knowledge; and we may define industrial research as technical investigation having more or less directly utilitarian objects such as the production or improvement of materials, processes and manufactured goods.

There is an intermediate grade of research usually classed as scientific, consisting of more or less detached investigations into fundamental problems of industry and manufacture, and the accumulation of scientific data which constitutes or should constitute the basis of industry.

We may call those engaged in these three grades of research the scientist, the technologist, and the consultant respectively. It is evident that no one grade of man can satisfactorily fulfil the requirements of more than one of these grades of research. His fitness for either depends on his education, training, temperament and mentality.

The pure scientist is a product of the highest training that can be devised and afforded by our universities, the greatest intellectual asset a country can have. His work is necessarily more or less specialised.

In addition to his close specialisation, a general characteristic of the physicist or pure scientist is lack of sympathy with the industrial application of science. By reason of the detachment consequent on these characteristics the pure scientist is obviously far removed from constituting in himself the required link with industry. A point worthy of note in connection with the work of our scientists and physicists, and one which undoubtedly has a relation to our national characteristics as compared with those of other nations, is the absence of speculation and eagerness for precedence and notoriety which is painfully apparent in some other countries. The technologist has up to the present usually been the product of our technical schools and colleges.

Until recently the general state of industry with relation to science has not been compatible with the technical adaptation of university trained men, and, on the other hand, their training has been too academic in relation to the state of industry.

The trend of scientific education, the progress of industry towards scientific methods, and the consequent release from drudgery of the technologist so that he can make efficient progress in industrial research, combine to demand that his status and training facilities shall be improved. When this is [illegible] he will constitute the most efficient link we can have between science and industry, because he will be potentially able by reason of his scientific equipment on the one hand, and experience on the other, to span the gulf which separates them at almost any [illegible] point.

The scientific consultant has been in the past a kind of pioneer of science in industrial territory, and it was [illegible] rather than to the physicist or pure scientist that the manufacturer appealed to for help over industrial snags. He has not, however, [illegible] been in such intimate contact with the ramifications of specialised manufacture as the technologist.

In recent years the manufacturer has [illegible] cases been able to appeal for scientific [illegible] to such sources as the National Physical Laboratory, the Imperial Institute and the research panels of his professional institutions, trade associations and Chambers of Commerce, [illegible] the [illegible] of the demands made upon them has resulted in their pure research work being more or less dominated by consultative and proving house work. They have, therefore, only partially fulfilled those functions which should be covered by the separately co-ordinated and jointly correlated work of our universities and our industrial research laboratories.

Generally it may be said that the chief hindrance to the co-operation of science with industry has been attributable to the lack of scientific knowledge on the part of the manufacturer. Consequently it was in a narrow and diffident spirit that industry approached science. In the early days the advances towards co-operation usually came from the other direction, and were often received by industry with suspicion. In consequence of this attitude, industry as a rule got no more than it deserved. [illegible] arrayed to render itself attractive to industry.

Happily, during the past 20 years or so, owing to the [illegible] advance of scientific education, the manufacturer has gradually realised that the function of science was not merely to give occasional assistance, and that the requirements of progress demanded the services of trained [illegible] with him. The [illegible] tions to co-operate in all matters relating to education and research, is now prepared to [illegible] advance.

In future progress the Imperial Government must lead the way, supported by the Government Departments, the educational authorities, the scientific societies and the professional bodies. The industrial associations and federations and commercial institutions must also contribute their influence and resources. And in addition, to securing co-operation between the individual manufacturers [illegible] of the general public must be enlisted.

PYROMETERS AND PYROMETRY.

(Concluded from p. 264.)

In what follows we conclude our account of the discussion held by the Faraday Society on this subject. The Papers by Messrs. Northrup, Whipple and Brown were given in our issue of Nov. 16 and by Messrs. Griffiths and Schofield in our last issue.

DISCUSSION.

Mr. A. J. WEBB, speaking with regard to the tin pyrometer, suggested that it was not possible to adopt that in the case of rare metals, and asked to know how the temperature of the [illegible] of the rare metals and the copper leads was adjusted. [illegible] to be a possible difficulty when using high temperatures [illegible] to make full use of the 10ft. or 20 ft. of cold ground.

Mr. J. [illegible] said that no mention [illegible] of the Papers of the Wiborgh pyrometer, which had [illegible] in 1885, and had been used most successfully [illegible] the temperatures of air blast furnaces.

Mr. H. S. [illegible] said he was [illegible] at the time Dr. Northrup made his preliminary investigation [illegible] whether the furnace would be useful [illegible] the cost of the installation [illegible]

[illegible]

in the thread recorders of the [illegible] and if that were so it should have been stated in the Paper.

Mr. C. E. FOSTER said that [illegible] junction had previously been [illegible] to large furnaces was very [illegible] the Brown instrument was [illegible] forgotten the name of the inventor. The automatic control of a furnace by means of a pyrometer was [illegible] make an instrument [illegible] made inquiries in America [illegible] operators were taking the readings [illegible]

Mr. S. N. BRAYSHAW [illegible] for standardising the pyrometers [illegible] Whipple [illegible] commercial [illegible] property. He [illegible] Mr. Whipple [illegible] loss of temperature [illegible] reading [illegible]

Mr. F. H. [illegible] said [illegible]

[illegible]

difficulty of [illegible]

[illegible]

stanced a large blast furnace installation in which a temperature of 700 deg. was maintained quite successfully.

Prof. ARNOLD (Sheffield University) speaking upon pyrometry applied to the hardening of high-speed steel, gave figures of a number of researches that had been carried out at Sheffield by selected senior undergraduates with various thermometers. These results were so close to each other that he had almost come to the conclusion that properly used, no matter the type of pyrometer adopted, reliable results could be obtained. At any rate, the results rather pointed to the fact that many failures were due to lack of skill on the part of the operators. The pyrometers used were the Féry, the Féry spiral spring, the Foster base-metal thermocouple, the Liskole optical or modified manner, and the Mesuré and Novel. He had a great affection for the latter if he could only get an observer who had got into the way of making accurate results.

Prof. F. G. DONNAN briefly discussed the manner in which molten copper and molten gold depart in their optical properties much more strongly than steel, from full radiation, and indicated the corrections necessary to be made. The curves of fires giving the correction were obtained in experiments made by him at Liverpool, and he added the precaution to anybody using an optical pyrometer in this connection to use it at right angles to the surface of polarisation. Unless it were used in that way, light would be emitted from the glowing metal, and interfere with the accuracy of the results.

Mr. COSMO JOHNS read a Paper on

"The Determination of the Temperature of Liquid Steel under Industrial Conditions."

In it he discussed in detail the sources of error and accuracy obtained in using measuring instruments in industrial practice, the temperature distribution in the furnace hearth, temperature gradient in the bath, variations in the stream of metal and thermal losses. The conclusion arrived at is that in the manufacture of acid open hearth steel a trained observer using a correct type of pyrometer can obtain readings of sufficient accuracy, when the necessary precautions are taken to secure effective control of the process. Under the most favourable conditions the apparent temperature can be read to within 3 deg. ± and under normal conditions to less than 5 deg. [illegible]. As divergences from a determined "normal" are sufficient for this control, the pyrometer readings can be used to determine temperature differences without importing any serious error. The most suitable instrument is an optical pyrometer using monochromatic light $\lambda 0{\cdot}70\mu$, which it is suggested should be adopted as a standard. It should have a scale that can be read under industrial conditions to 2 deg. The variations in the true temperature of open hearth steel are very small, and the desirable limits in good practice range within 30°C. The thermal losses are small once the steel has been covered with slag in the ladle. The most consistent results are obtained when observing plane surfaces or curved ones with a large radius.

NOTES ON PYROMETRY FROM THE STANDPOINT OF FERROUS METALLURGY.

BY DR. W. H. HATFIELD.

In large armament works the adequate control of temperature in metallurgical operations is vital.

One important portion of the Brown Firth Research Laboratory is devoted to the standardisation and maintenance of the pyrometers used throughout their different works, and one of its functions is to follow closely the development of pyrometry.

All operations, melting, forging, rolling, annealing, hardening, tempering, &c., are best executed within some particular range of temperature. For the investigatory side of the work, temperature readings should be preferably in absolute values; for industrial processes the instrument need not necessarily give such values directly, but those actually recorded should be readily transposed.

The Measurement of the Temperature of Molten Steel.—Although the temperature at which steels are cast must have an influence upon their ultimate physical properties, no ready and really reliable method for measuring such temperatures from the works standpoint is possible. There is no satisfactory relationship between the temperatures of the furnace chamber and slag, and the metal [illegible] the furnace. Probably a study of the emissivity of different [illegible] might lead to useful information and assist in some of the [illegible].

It would seem to be of considerable use if the temperature of an [illegible] could be controlled and determined.

Determination of the temperature of steel bodies under some typical works operations presents another interesting problem. It is sometimes assumed that with suitable corrections the readings of an optical pyrometer will give all that is required, and that the [illegible] might be comparable with one another. This, however, does not quite state the whole of the case. In forging, [illegible] the hot body comes into intimate contact with the large masses of steel forming the hammer and die, and as the body is rotated during the forging operation the outside becomes considerably cooled.

Again, whilst the thermo-electric pyrometer forms an accurate, convenient and easily adjustable instrument, sufficient attention is not always given to the manner in which the couple is placed relative to the steel. This comment really applies to all operations which involve the heating up of masses of steel.

The question of heat penetration is another important field for research.

The determination of thermal conductivity of various materials has been attempted by numerous methods. The following results connecting thermal and electrical conductivity may be of interest.

Material.	Relative thermal conductivity.	Relative electrical conductivity.
Wrought iron	100·0	100·0
0·9 per cent. carbon steel, as rolled	65·3	58·4
25 per cent. nickel steel	25·8	12·25
Air-hardening nickel-chrome steel, as rolled	40·6	34·5
High-speed steel, as rolled	38·0	36·2
High-speed steel, hardened	28·8	17·2

These results are only at room temperature over a range of 10°C. to 40°C., and the electrical conductivities are given for comparison. It has been usually considered that thermal and electrical conductivities follow each other very closely, and it has been suggested that in accordance with the electronic theory of conduction the ratio between the two should be quite constant at a given temperature, and increase in proportion to the absolute temperature.

Dr. A. MCCANCE, referring to temperature determinations of liquid steel, said he had had a lot of trouble with electric furnaces, and it was thought that, perhaps, the pyrometer would give some indication of how to control and prevent much of the trouble that was being experienced. Experiments were therefore carried out at the Parkhead Steel Works; these not only solved the problem for their own practical needs, but a scale had been devised from which they were taking between 10,000 and 12,000 determinations on liquid steel alone during the year. The first trouble was the pyrometer. He had a Siemens pyrometer which was of the telescope type, and the colour of the object whose temperature was being taken was compared with the colour of an electric lamp. There was at first great trouble in getting the milliampere meters to stand up to rough usage in the shop, and it also took some time to train the men to take reliable observations. Another great difficulty was with the supply of lamps which came from Germany, and which when compared with lamps calibrated at the National Physical Laboratory showed a difference of 20 deg. in the scales. That was a very important matter, and attention should be drawn to it. Another point was that instruments sent out by the same makers and intended to be identical were often found to show a difference of 15 to 20 deg; that was a matter the manufacturers should look into. The wave-length of pyrometers was yet another important matter. He had tried the experiment of taking off the reed screen from the Siemens pyrometer and introducing different coloured screens. Using a thermo-couple the black body temperature was 1,189 deg., and with an optical pyrometer using a red screen it was 1,186 deg. Using a yellow screen the figure was 1,133, with a green mercury it was as low as 920, and with a blue it was almost impossible to read the temperature at all.

Dr. J. A. HARKER defended the manufacturers of pyrometers from the implied slur in the remarks of the previous speaker, and pointed to the progress that was being made in the construction of pyrometers. It was very difficult to make optical pyrometers absolutely independent of the object upon which they were focussed. There was a perfectly definite variation with certain types of instrument which was just as inherent as spherical abberation in a lens which could not be got rid of unless they had a relatively large object. Hence it was difficult to ensure that the instrument which was being calibrated would give the same reading at the same temperature outside the laboratory when the object was a big thing like a mass of steel in a ladle.

Dr. MCCANCE said he had no intention of casting any slur upon the manufacturers. He was only mentioning difficulties he had come up against.

Dr. F. ROGERS said he was not at all satisfied either with radiation pyrometers or optical pyrometers, and he had devised a thermo-couple which he had been using with a considerable amount of success, which was actually immersed at its ends into the molten metal through the roof of the furnace. There were a number of practical details yet to be worked out, but even now the instrument was a usable one.

Mr. F. PEAKMAN suggested that a further evening might be given to a discussion of the lower temperatures used in the hardening shop in which steel was heated to 875 or 900 deg. and then re-heated to 750 deg.

Mr. [illegible] spoke of the application of pyrometers in glass manufacture, and referring to the manufacture of glass for pyrometers said that if pyrometer makers would only specify exactly the glass they would require, giving the refractive indices, &c., a glass would be discovered which would suit their purpose. When once a glass was discovered one melting would supply all the output almost for ever.

Dr. WALTER ROSENHAIN said it was not only important to get a correct temperature, but also to see that the temperature obtained was the temperature which was really wanted to be known. The use of pyrometers

was becoming fashionable at the present time, and they were being extensively used in many cases in a manner which was worse than useless. So far as thermal conductivity was concerned, it was not sufficient even approximately to take the thermal conductivity of a metal at the ordinary temperature from 100 down to 0, but it was necessary to determine the thermal conductivity and the specific heats at the high temperature involved in the work. At Teddington they had come across the problem in quite another connection—viz., aluminium alloys—and Dr. Griffiths had developed a method of determining the thermal conductivity at different temperatures up to 1,300 deg., and if funds were provided it was possible to go very much higher indeed. He doubted whether Mr. Rogers would find his platinum iridium wires stand up in the furnace.

Mr. W. CARTER said that pyrometers were sold too cheaply, and perhaps for that reason users got little assistance from the makers. He had an instrument in his works which he did not know how to use, and was waiting for the manufacturer to instruct him. He did not think the makers themselves were sufficiently instructed in the use of the instruments, which, by the way, were made far too much on laboratory lines, so that they would not stand up to workshop conditions. It was also overlooked that the conditions in a hardening shop were by no means good, and the men had to spend a lot of time trying to read the scales to 1 deg., and perhaps finally had to guess to 10.

Mr. R. S. WHIPPLE, as a manufacturer, said it was a very difficult matter to suit all teastes, and the pyrometer maker was often up against a hard problem. He could tell a good many stories of the use of pyrometers which perhaps would not be believed, but he had come to the conclusion that 90 per cent. of pyrometers were not burned out, but were broken mechanically, because they were put in in such a position that the man in putting the work into the furnace could not help knocking the head off. At the same time it would be agreed that pyrometry had advanced a very great deal, for the makers were now asked to supply instruments, and did supply them, with an accuracy of 2 deg. working at 1,500 deg.

THE MEASUREMENT OF HIGH TEMPERATURES BY MEANS OF POTTERY MATERIALS.

BY HENRY WATKIN.

Clays vary very much in plasticity. There are now innumerable compositions for the pottery and porcelain manufacture which depend largely for their value upon the correct amount of heat given to each particular composition. The effect of heat upon such materials (1) diminishes the size of the clay product while hardening and retaining permanently the form of same; (2) renders the articles made therefrom partially or completely impervious to moisture; (3) fuses the glaze and provides a perfectly smooth gloss on the surface of the otherwise rough body; (4) it fuses either upon or under the glazed surface any decoration that may be desired, and renders the same permanent. The intensity or degree of the fire required to bring about these results varies according to the materials used and the ends obtained.

The means by which many of these firing points were known to the potters of a century or more ago leaves no doubt that they must have possessed some system of pyrometry, founded on changes in the condition of the materials used in the manufacture during the heating process.

For example:

Sight.—1. The colour of the flames would not escape his attention, and he would soon learn the progressive changes from incipient red to incandescence.

2. The changes in colour which red clay undergo progressively with increasing heat.

3. Translucency of the trial pieces in such productions as parian bone china, felspathic porcelain.

4. The development of the [illegible] tint in [illegible] colour.

5. The diminution of bulk, or contraction.

Feeling or Touch.—The [illegible] of the material, the hardness, the weight, the density, would, in the hands of an experienced fireman, confirm the indications given to [illegible].

Hearing.—The goods when fired, if struck by a piece of metal or by another piece of the same pottery, give out sounds which vary according to the degree of heat at which they were fired, &c., and, suitably selected, may give the [illegible].

That contraction or diminution [illegible] takes place during the firing could be conveniently [illegible] the [illegible] of the great Josiah Wedgwood. The Wedgwood pyrometer [illegible] probably the best instrument [illegible] for the measurement of high temperatures. It has been [illegible] the materials of which the test pieces are made [illegible] the form and method by which they are [illegible] the instruments by which the test pieces are measured.

[illegible] trial rings, also based on the principle of the contraction of clay, have been adopted by all the leading potters throughout Great Britain, [illegible] in diameter and [illegible] As the ring contracts during the different stages of firing the changes are noted on special charts, and a practical guide [illegible] upon the firing is thereby obtained.

About 54 years after Wedgwood's discovery, Messrs. Voight & Light, of Paris, perceived the advantage of utilising the fusibility of materials. Taking china clay, felspar and lime, &c., they made a series of mixtures with different degrees of softening points made up into cones, which distorted in such a manner as to be easily observed when they reached certain degrees of heat. In 1886 Seger made up a series of cones having melting points from 1,150 deg. to 1,390 deg., which he numbered 1 to 35, which were subsequently increased by Cramer, who produced a series with lower melting points from 590 deg. to 1,130 deg., and which were numbered 022 to 01.

BASE-METAL THERMOELECTRIC PYROMETERS.

BY CHAS. R. DARLING, A.R.C.S., F.I.C.

A notable feature in pyrometry during the last decade has been the introduction of base-metal thermoelectric pyrometers. This is due in part to the steadily increasing cost of platinum and kindred metals; also base-metal couples possess other advantages—*e.g.*, the development of an E.M.F. several times as great as that given by a couple of platinum and platinum-rhodium alloys; this enables more robust indicators and recorders to be used, or a more exact reading to be taken over a given range.

The couples commonly employed are iron-constantan; two iron-nickel alloys of different composition; and two different nickel-chrome alloys, known as Hoskins' alloys. Iron alloys containing aluminium are also used, the couples chosen being such as to yield a relatively high E.M.F., increasing uniformly with temperature. British base-metal pyrometers are quite reliable if used within the prescribed limits. Prolonged heating near the limiting temperature appears to affect all alloys, and the safe limits for steady and casual heatings are usually notified by the maker.

Up to the present no base-metal couple has been brought into use capable of being used continuously at temperatures above 1,000 C.; but one may extend the range over which base-metal couples may be used by utilising the E.M.F. developed by a junction in which one or both of the metals may be in the liquid state. Metals such as tin, aluminium and copper, which could not be used in an ordinary pyrometer in which fusion would destroy the couple, may be used up to temperatures approaching their boiling points if the junction is maintained.

The question arises whether metals in the molten state develop an E.M.F. suitable for pyrometric work. This method has been studied by the author and A. W. Grace.* In general, the thermoelectric properties are unaffected by fusion, and that a temperature E.M.F. curve shows no discontinuity at the fusion point. Exceptions to this rule are furnished by bismuth and antimony, both of which show an abrupt bend in the curve at the melting point. In the original Paper a working pyrometer utilising the principle outlined above is described, the metals forming the couple being inserted into a graphite block and their ends connected to a millivoltmeter.

Owing to the lateness of the hour there was no discussion [illegible] of these Papers, and the meeting adjourned.

Electrical Production of Rain.—According to an Australian patent applied for by Mr. [illegible], of Victoria, electricity can be utilised to promote the falling of rain [illegible].

The specification states that [illegible] tained between the cond[illegible]

* [illegible] XXIX [illegible] December, 1916.

ON THE EFFECT OF ARMATURE RESISTANCE AND REACTANCE ON THE TERMINAL PRESSURES OF A ROTARY CONVERTER.

BY S. NEVILLE, B.SC., D.I.C.

(*Concluded from page* 269.)

7. Resistance Drop.

Let R denote the resistance of the armature winding as measured between successive brushes—that is, the resistance of the two halves of the armature, each of angular length π, in parallel. Then the resistance per unit angular length of the periphery is obviously $2R/\pi$. The total current in a conductor at the point a is the sum of the continuous current and alternating-current components, and hence the total or resultant resistance drop between any two points a and a' is obtained by integrating the sum of the expressions already given ; thus

$$e_r = \frac{2}{\pi}R\int_a^{a'}(I_a - i_a)\,da.$$

$$= IR\frac{4}{\pi^2}\left[\Sigma\frac{1}{n^2}\sin n\theta\,.\,(\sin na' - \sin na) - \Sigma\frac{1}{n^2}\cos n\theta\,.\,(\cos na' - \cos na)\right]_B$$

$$- iR\frac{2N}{\pi^2}\sin\frac{\pi}{N}\left[\Sigma\frac{1}{n^2}\sin(\theta - \varphi)\,.\,(\sin na' - \sin na) - \Sigma\frac{1}{n^2}\cos(\theta - \varphi)(\cos na' - \cos na)\right]_A. \quad (12)$$

It is now only necessary to insert in this general expression suitable values for the angles a and a' in order to obtain the expressions for the total resistance drop at those pairs of terminals which are of practical interest. Three particular cases of special importance will be considered, namely,

I. $a = \theta$, $a' = \pi - \theta$, gives the resistance drop between successive direct-current brushes on the commutator.

II. $a = 0$, $a' = 2\pi/N$, gives the resistance drop between adjacent alternating-current tappings or slip-rings—*i.e.*, in the pressure required for a "polygon" supply.

III. $a = 0$, $a' = \pi$, gives the resistance drop between diametrically opposite alternating-current tappings or slip-rings —*i.e.*, in the pressure required for a "diametral" supply.

The last case is, of course, only practicable where N is an even number.

8. Case I.—Pressure between Direct-current Brushes.

For $a = \theta$ and $a' = \pi + \theta$, then

$\sin na' - \sin na = \sin n\theta(1 - \cos n\pi) = 0$, if n is even,
$= 2\sin n\theta$, if n is odd.

$\cos na' - \cos na = \cos n\theta(\cos n\pi - 1) = 0$, if n is even,
$= 2\cos n\theta$ if n is odd.

Substituting these values, the above expression reduces, on [illegible] to

e_r = IR … [Σ 1/n² sin nθ sin nθ … Σ 1/n² cos nθ cos nθ]_B … iR 4N/π² sin π/N [Σ 1/n² sin (θ − φ) sin nθ … Σ 1/n² cos (θ − φ) cos nθ]_C

= IR 8/π² [Σ 1/n²]_B − iR 4N/π² sin π/N [Σ 1/n² cos (φ − KNθ)],

where the latter … that only *odd* values of n … [illegible] … $1 \pm KN$ … to be used … [illegible] … between … [illegible]

$$\Sigma\frac{1}{n^2} = \frac{\pi^2}{8}$$

[illegible]

e_r = IR − iR … sin π/N [Σ 1/n² cos (φ … KNθ)]. (13)

[illegible] … the machine is working … the power delivered by the armature … [illegible] … p. 187.

continuous current to that supplied to the armature as alternating current, it may readily be shown * that in a rotary converter

$$i = 2I/N\sin\frac{\pi}{N}\,.\,\eta\cos\varphi,$$

and hence under these conditions the resistance drop at the commutator may be written in terms of the continuous current alone as

$$e_r = IR - IR\frac{8}{\pi^2\eta\cos\varphi}\left[\Sigma\frac{1}{n^2}\cos(\varphi - KN\theta)\right]_C.$$

Inserting the value $K=0$ in the latter term of this expression, the constant component of the resistance drop due to the alternating current is obtained ; this is most conveniently combined with the drop due to the continuous current, giving

$$e_r = IR\left[1 - \frac{8}{\pi^2\eta}\right] - IR\frac{8}{\pi^2\eta\cos\varphi}\left[\Sigma\frac{1}{n^2}\cos(\varphi - KN\theta)\right]_C K \neq 0. \quad (14)$$

The first term in this expression represents the *mean* value of the pressure drop at the commutator, while the second term gives the magnitudes of the harmonics constituting the ripple which is superposed on the steady pressure. It will be seen that these harmonics are fairly small and their frequencies are only multiples of the number of phases. An example of the actual shape of the ripple will be given later.

Any polarised voltmeter would indicate only the mean value of the pressure and the resistance drop so measured would therefore be

$$E_r = IR\left[1 - \frac{8}{\pi^2\eta}\right].$$

It should be noticed that this quantity is entirely independent of the number of phases. It is also of course independent of the power factor of the machine, but varies considerably with the efficiency. When η is unity, as in a machine being … driven by its starting motor, the factor in the … is a small positive quantity—that is, there is an actual

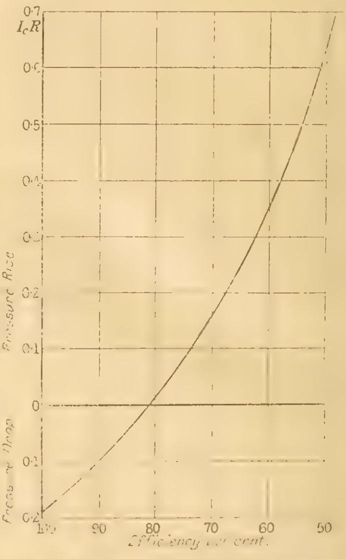

FIG. 2.—PRESSURE DROP AT D.C. BRUSHES.

* Arnold, "Wechselstromtechnik," Bd. IV., S. 687.

resistance drop at the brushes such as would be due to the continuous current output alone, but of much smaller magnitude. With a low efficiency this becomes a negative quantity, and may be large at very low efficiencies, that is, the pressure at the brushes may *exceed* the induced pressure. At a critical efficiency $\eta=8/\pi^2$, there is no resistance drop whatever. In Table I. is given the value of the factor in the brackets for various efficiencies, and these figures are plotted in Fig. 2.

Table I.—*Effect of Efficiency on Resistance Drop at Direct-current Brushes.*

η	$1-\frac{8}{\pi^2\eta}$.		η	$1-\frac{8}{\pi^2\eta}$.	
100	0·1894	pressure drop.	75	0·0808	pressure rise.
95	0·1467		70	0·1580	
90	0·0993		60	0·3510	
85	+0·0464		50	0·6212	
81·06	0		25	2·2424	

9. CASE II.—PRESSURE BETWEEN ADJACENT POLYGON TAPPINGS.

If $\alpha=0$ and $\alpha'=2\pi/N$, then

$$\sin n\alpha'-\sin n\alpha=2\cos n\frac{\pi}{N}\cdot\sin n\frac{\pi}{N}.$$

$$\cos n\alpha'-\cos n\alpha=-2\sin n\frac{\pi}{N}\cdot\sin n\frac{\pi}{N}.$$

Inserting these values and simplifying, the general expression becomes

$$e=IR\frac{8}{\pi^2}\left[\Sigma\frac{1}{n^2}\sin n\frac{\pi}{N}\cdot\sin n\left(\theta-\frac{\pi}{N}\right)\right]_B$$

$$\quad iR\frac{4N}{\pi^2}\cdot\sin n\frac{\pi}{N}\left[\Sigma\frac{1}{N^2}\sin n\frac{\pi}{N}\ [illegible]\ \left(\theta-\phi\ [illegible]\ n\frac{\pi}{N}\right)\right]_A.$$

Now, inserting the condition $n=KN\pm1$ in the latter term and remembering that $\sin n\frac{\pi}{N}=(-1)^K\ [illegible]\ \frac{\pi}{N}$ as deduced in section 4, this further reduces to the form,

$$e=IR\frac{8}{\pi^2}\left[\Sigma\frac{1}{n^2}\sin n\frac{\pi}{N}\cdot\sin n\theta'\right]_B\ [illegible]\ R\frac{4N}{\pi^2}\ [illegible]\ \frac{\pi}{N}\left[\Sigma\frac{1}{n^2}\ [illegible]\ \sin(\theta'-\phi)\right].$$

where $\theta'=\theta-\frac{\pi}{N}$.

But it may be shown that when $n=1\pm KN$ and K is any positive integer or zero

$$\sum_1^\infty\frac{1}{n^2}=\frac{\pi^2}{N^2}\ \frac{1}{[illegible]\ \frac{\pi}{N}}$$

hence the above expression becomes

$$e=IR\frac{8}{\pi^2}\left[\Sigma\frac{1}{n^2}\sin n\frac{\pi}{N}\ \sin n\theta'\right]\ [illegible]\ R\frac{1}{N}\ [illegible]\ (\theta'-\phi)\quad(15)$$

In dealing with the pressure at the slip-rings it will generally be most convenient to express the resistance drop entirely in terms of the alternating current per phase. Hence, inserting the value

$$I=\frac{N}{2}\ [illegible]\ \frac{\pi}{N}\ [illegible]$$

it will be seen that

$$e=iR\frac{4N}{\pi^2}\ [illegible]\ \frac{\pi}{N}\ \eta\cos\phi\left[\Sigma\ [illegible]\ \right]_B\ [illegible]\ R\frac{1}{N}\ [illegible]\ (\theta'-\phi)$$

Putting $n=1$ in the first term, the [illegible] of the fundamental frequency in the pressure drop due to the continuous current is obtained, which is [illegible] with the component due to the [illegible]. Thus

$$e=R\frac{4N}{\pi^2}\ [illegible]\ \frac{\pi}{N}\ [illegible]\left[\ [illegible]\ \right]$$

$$\quad R\frac{1}{N}\left[\left(\frac{N}{\pi}\sin\frac{\pi}{N}\right)^2\ [illegible]\right]\quad(16)$$

where $n=1$.

* [illegible]

It will be seen that here also the harmonics are all small, depending upon the inverse square of their orders. Then, since the effect of any harmonic upon the effective or R.M.S. value of the whole wave is proportional to the square of its amplitude, it will be obvious that these harmonics can never have an appreciable effect on the measured terminal pressure, and the effective resistance drop may, therefore, be taken as identical with the R.M.S. value of the fundamental component. It will be seen that where a low power-factor has to be taken into account the second term of the above expression, which represents the fundamental wave, does not admit of tabulation as in the previous case, since it consists of the resultant of two pressures of different phases. But if it be assumed for simplicity that the power factor is practically unity, this term may be much simplified, and gives as the effective or R.M.S. value of the resistance drop,

$$E_r=\frac{i}{\sqrt{2}}R\frac{1}{N}\left[\left(\frac{N}{\pi}\sin\frac{\pi}{N}\right)^2\eta\cos\phi-1\right].$$

The quantity in the round brackets is the well-known winding "distribution-factor" for the fundamental in the phase pressure, and in this case, therefore, the resistance drop depends essentially upon the number of phases. The value of

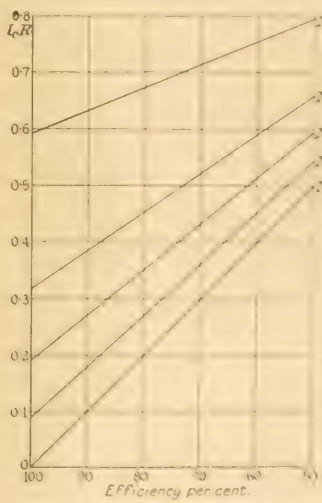

Fig. 3.—[illegible]

the whole term in the square brackets is given in Table II. for common numbers of phases and various values of the combined factor $\eta\cos\phi$, and is also plotted in Fig. 3. It is important to notice that the sign of this term is always negative, that is, the pressure at the slip-rings is [illegible] the induced pressure. It [illegible] that the term $R\frac{1}{N}$ is the resistance of one phase of the winding, or the actual resistance of the [illegible] per phase.

Table II.—[illegible]

$$[illegible]\left[\ [illegible]\ \right]$$

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
100	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
95	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
90	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
85	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
80	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
75	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

10. Case III.—Pressure between Diametral Tappings.

If $\alpha=0$ and $\alpha'=\pi$, then

$\sin n\alpha'-\sin n\alpha=0$;

$\cos n\alpha'-\cos n\alpha=0$, if n is even; $=-2$, if n is odd.

But it should be observed that since this case is only applicable where N is an even number, the possible values of n are limited to odd numbers by the primary condition $n\pm1=KN$. Hence, substituting in the general expression, as before,

$$e_r=IR\frac{8}{\pi^2}\left[\Sigma\frac{1}{n^2}\cos n\theta\right]_B-\bar{\imath}R\frac{4N}{\pi^2}\sin\frac{\pi}{N}\left[\Sigma\frac{1}{n^2}\cos(\theta-\varphi)\right]_A$$
$$=IR\frac{8}{\pi^2}\left[\Sigma\frac{1}{n^2}\cos n\theta\right]_B-\bar{\imath}R\frac{4}{N}\cdot\frac{1}{\sin\frac{\pi}{N}}\cos(\theta-\varphi). \quad . \quad (17)$$

and again expressing I in terms of $\bar{\imath}$, and combining the two terms of fundamental frequency, this becomes

$$e_r=\bar{\imath}R\frac{4N}{\pi^2}\sin\frac{\pi}{N}\cdot\eta\cos\varphi\left[\Sigma\frac{1}{n^2}\cos n\theta\right]_B$$
$$-\bar{\imath}R\frac{4}{N}\cdot\frac{1}{\sin\frac{\pi}{N}}\left[\left(\frac{N}{\pi}\sin\frac{\pi}{N}\right)^2\eta\cos\varphi\cdot\cos\theta-\cos(\theta-\varphi)\right]. \quad . \quad (18)$$

where $n\neq1$; and therefore

$$E_r=\frac{\bar{\imath}}{\sqrt{2}}R\frac{4}{N}\cdot\frac{1}{\sin\frac{\pi}{N}}\left[\left(\frac{N}{\pi}\sin\frac{\pi}{N}\right)^2\eta\cos\varphi-1\right].$$

The similarity to the previous expression is obvious. The magnitudes of certain of the harmonics are very different on account of the absence of the term $\sin n\frac{\pi}{N}$ of the last case. In the effective or R.M.S. value, the quantity in the square brackets is identical with that already plotted, and the actual magnitude of the drop differs from that of the previous case only by the factor $1/\sin\frac{\pi}{N}$.

It is interesting to note that in the instance of $N=2$, the common single-phase machine, the cases II. and III. are identical, and it will be found that if this value be inserted the above expression readily reduces to that obtained directly for the previous case.

11. Example.

In order to demonstrate the relative importance of the various harmonics and the general nature of the wave-forms obtained, a numerical example has been worked out for the commonest practical case, namely, a six-phase converter transforming energy from alternating to continuous current. For the sake of simplicity it has been assumed that the efficiency of the machine is unity, or 100 per cent., and that the power-factor is also unity, *i.e.*, $\cos\varphi=1{\cdot}0$ and $\varphi=0$. It will be recognised from equations (11), (16) and (18) that these assumptions affect only the *mean* pressure in case I., and the values of the *fundamental* in cases II. and III., and have no influence upon the magnitude and form of the superposed ripple.

If $N=6$, $\eta=1{\cdot}0$ and $\cos\varphi=1{\cdot}0$, then the current ratio of the machine becomes

$$i=\frac{2I}{N\sin\frac{\pi}{N}\cdot\eta\cos\varphi}=\frac{2}{3}I.$$

To facilitate comparison, the curves for the three cases have been plotted to a common scale, namely, IR units, and therefore $\bar{\imath}R$ ... In all cases a pressure drop has been plotted as negative and a pressure rise as positive; then to obtain the waves of terminal pressure the plotted curves have to be directly superposed upon the waves of induced pressure. The same wave-length and the same origin has been used for all cases.

Case I.—Using equation (11) and inserting the values given above, it will be found that the curve to be plotted is

$$e_r=\left[1-\frac{8}{\pi^2}\right]-\frac{8}{\pi^2}\left[\Sigma\frac{1}{n^2}\cos 6K\theta\right]$$

for all values of n satisfying the condition $n\pm1=6K$, where K is any positive integer but not zero. Only odd values of n can occur, but the actual harmonics produced in the pressure wave are only even. Then, taking successive values of K, the series becomes

$$e_r=\left[1-\frac{8}{\pi^2}\right]-\frac{8}{\pi^2}\left[\left(\frac{1}{5^2}+\frac{1}{7^2}\right)\cos 6\theta+\left(\frac{1}{11^2}+\frac{1}{13^2}\right)\cos 12\theta\right.$$
$$\left.+\left(\frac{1}{17^2}+\frac{1}{19^2}\right)\cos 18\theta+\left(\frac{1}{23^2}+\frac{1}{25^2}\right)\cos 24\theta+\dots\right]$$

or numerically,

$$e_r=0{\cdot}1894-0{\cdot}0490\cos 6\theta-0{\cdot}0115\cos 12\theta-0{\cdot}0051\cos 18\theta$$
$$-0{\cdot}0028\cos 24\theta-\dots].$$

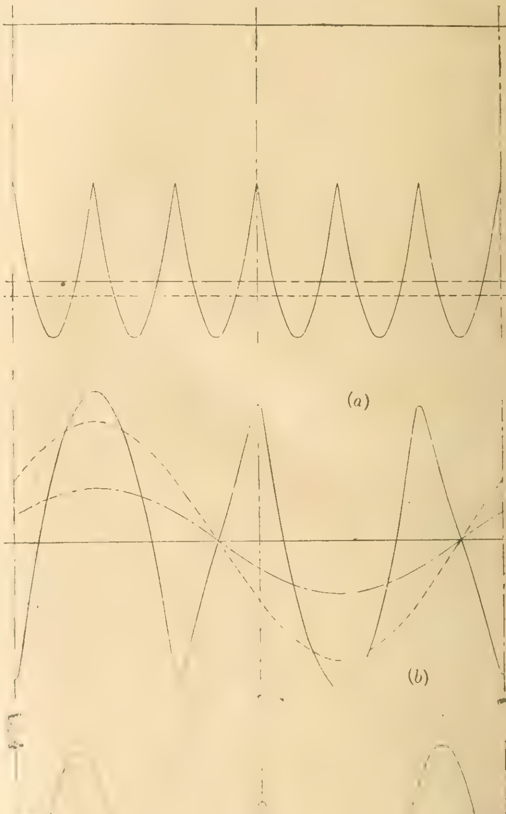

Fig. 1. Wave-form of Pressure Drop.
(a) At direct current brushes; (b) at adjacent polygon tappings; (c) at diametral tappings.

The equation is plotted as far as the 24th harmonic in Fig. 1 (a). The chain line represents the mean value of the wave, and the dotted line represents the normal pressure drop IR,

due to the continuous current alone, to *one-tenth* of the scale of the wave itself; and shows clearly the importance of the neutralising effect of the alternating currents.

Case II.—Inserting the same values in equation (16), the expression becomes

$$e_r = \frac{8}{\pi^2}\left[\Sigma \frac{1}{n^2} \sin n\frac{\pi}{6} \cdot \sin n\theta'\right] + \frac{8}{18}\left[\left(\frac{6}{\pi} \sin \frac{\pi}{6}\right)^2 - 1\right] \sin \theta'$$

for all odd values of n except unity, where $\theta' = \theta - \frac{\pi}{6}$.

Taking successive values of n as far as the 17th harmonic, the numerical terms of the series are found to be

$$e_r = \frac{8}{\pi^2}\left[\frac{1}{3^2} \sin 3\theta' + \frac{1}{2} \cdot \frac{1}{5^2} \sin 5\theta' - \frac{1}{2} \cdot \frac{1}{7^2} \sin 7\theta' - \frac{1}{9^2} \sin 9\theta' - \frac{1}{2} \cdot \frac{1}{11^2} \sin 11\theta' + \frac{1}{2} \cdot \frac{1}{13^2} \sin 13\theta' + \frac{1}{15^2} \sin 15\theta' + \frac{1}{2} \cdot \frac{1}{17^2} \sin 17\theta' \ldots\right] + \frac{8}{18}\left[\frac{9}{\pi^2} - 1\right] \sin \theta'.$$

$$= -0{\cdot}0391 \sin \theta' + 0{\cdot}0901 \sin 3\theta' + 0{\cdot}0162 \sin 5\theta' - 0{\cdot}0083 \sin 7\theta' - 0{\cdot}0101 \sin 9\theta' - 0{\cdot}0034 \sin 11\theta' + 0{\cdot}0024 \sin 13\theta' + 0{\cdot}0036 \sin 15\theta' + 0{\cdot}0014 \sin 17\theta' - \ldots$$

This is plotted in Fig. 4(*b*), together with the simple fundamental wave, which would be produced by the alternating current alone, drawn to *one-tenth* of the original scale as before.

Case III.—Using equation (18), and proceeding in exactly the same manner as above, the curve is given by the equation

$$e_r = \frac{8}{\pi^2}\left[\Sigma \frac{1}{n^2} \cos n\theta\right] + \frac{16}{18}\left[\left(\frac{6}{\pi} \sin \frac{\pi}{6}\right)^2 - 1\right] \cos \theta$$

for all odd values of n except unity; that is

$$e_r = \frac{8}{\pi^2}\left[\frac{1}{3^2} \cos 3\theta + \frac{1}{5^2} \cos 5\theta + \frac{1}{7^2} \cos 7\theta + \frac{1}{9^2} \cos 9\theta + \frac{1}{11^2} \cos 11\theta + \frac{1}{13^2} \cos 13\theta + \frac{1}{15^2} \cos 15\theta + \frac{1}{17^2} \cos 17\theta \ldots\right] + \frac{16}{18}\left[\frac{9}{\pi^2} - 1\right] \cos \theta.$$

$$= -0{\cdot}0782 \cos \theta + 0{\cdot}0907 \cos 3\theta + 0{\cdot}0324 \cos 5\theta + 0{\cdot}0165 \cos 7\theta + 0{\cdot}0101 \cos 9\theta + 0{\cdot}0067 \cos 11\theta + 0{\cdot}0048 \cos 13\theta + 0{\cdot}0036 \cos 15\theta + 0{\cdot}0028 \cos 17\theta + \ldots,$$

which is plotted exactly as before in Fig. 4 (*c*). It is very noticeable in both the last two cases that the third harmonic is of greater amplitude than the fundamental itself in the pressure drop. All the harmonics are, however, quite small in comparison with the fundamental of the total terminal pressure, and it is, of course, upon this fact that the method above used for obtaining the R.M.S. value of these waves depends for its accuracy.

12. REACTANCE DROP.

The reactance pressures at the various pairs of terminals may be readily calculated, as already mentioned, by using equations (13), (15) and (17) for cases I., II., and III. respectively, and neglecting the first term, which represents the component due to the continuous current in each case. The resistance R has to be replaced by the true reactance X measured between brushes at normal frequency, and the correct phase relationship will be obtained by substituting $\varphi - \frac{\pi}{2}$ for the phase-angle φ.

13. INVERTED ROTARY.

The case of a machine converting energy from continuous to alternating current is, of course, identical with that already examined, except that the sign of the pressure drop has in every case to be reversed; the meaning of the symbol η remains exactly the same as before, but is now always greater than unity. Tables I. and II. may be readily extended to include such values.

14. DOUBLE-CURRENT GENERATOR.

The pressure drop in the double-current machine may be at once dealt with by means of the formulæ already established if $-\eta$ be identified with the ratio of the power delivered as continuous current to that delivered as alternating current. The negative sign is required because both currents in this case represent an output of power, whereas the original equations were deduced for the case where one of the currents supplied power to the machine.

This Paper was written in connection with the post-graduate courses of the City and Guilds (Engineering) College, South Kensington, and the author wishes to express his indebtedness to Dr. S. P. Smith and to his colleague Mr. B. Hague, B.Sc., for their care in reading the manuscript and for helpful criticism.

GAS-FIRING BOILERS.*

BY T. M. HUNTER, M.A., B.SC.

(*Concluded from p. 271.*)

BOILER SETTING.

It is preferable to have a poor boiler with a good setting than the best boiler with a bad setting. The [illegible] of efficiency by way of boiler settings are twofold: the loss through infiltration of false air into the boiler through the brickwork, and the loss by radiation and conduction of heat from the boiler out through the brickwork. As regards the entry of false air, all this air must be heated to the exit temperature of the gases. The loss by infiltration of false air is in many cases a loss of efficiency of [illegible] per cent. or more.

[illegible] Leakage.—Brickwork settings have generally a very large number of small crevices, which are [illegible] to the eye. These crevices admit a great deal of false air [illegible] of the waste gases at different points [illegible]. In order to [illegible] it is necessary to cover the brickwork settings with [illegible], which should be renewed from time to time [illegible] of the brickwork [illegible] with [illegible]. [illegible] will [illegible] all crevices and will provide a [illegible] boiler setting.

Radiation and Conduction.—The losses through radiation and conduction of heat from a boiler are not [illegible] reduced. When we consider that there are boilers which lose [illegible] per cent. from these causes, and others which lose [illegible] per cent., it is evident that matter requires attention. Owing to the [illegible] of [illegible] large volumes of gas in the [illegible] it [illegible] it is practically impossible to [illegible] the radiation loss while gas firing a boiler. The [illegible] is to test this loss when coal firing the boiler, and to assume that the loss is the same while gas firing. The results of a large number of tests of well [illegible] boilers which were published some time ago showed that in no case was the radiation loss over 2½ per cent.

A mistake which is very frequently made is [illegible] when erecting the brickwork. The brickwork is often not thick enough. This is not a mistake confined to boilers, but [illegible] to gas producers and metallurgical furnaces. [illegible] light boiler settings, [illegible] will very soon be repaid [illegible]. [illegible] boiler in the open air, the radiation loss [illegible] is about 1 per cent. [illegible] would pay many times [illegible].

[illegible]

[illegible] the temperature of [illegible]. As regards the [illegible] that total combustion with [illegible] per cent. [illegible] a result as should be expected. A good [illegible] per cent., [illegible] usually [illegible] 20 per cent. [illegible] the [illegible].

[illegible] [illegible]

* Abstract of a Paper read before the [illegible] Electrical Engineers.

place very rapidly, at the highest possible temperature and with the smallest possible excess of air.

Combustion arrangements have to be designed to suit three different conditions of gas pressure :—

1. Steady pressure of 1 in. water gauge or more.
2. Intermittent pressure, ranging constantly from 1 in. water gauge or more, to nil, with total stoppage of the gas flow and extinction of the flame.
3. Very low gas pressure, or a pressure which may sometimes be high, but is low for considerable periods.

1. For a steady gas pressure the Bunsen type of burner gives the best results. Such burners would have been generally adopted years ago but for the technical difficulties in designing them. It is easy to design the small Bunsen burner we use in the laboratory, but much more difficult to design burners for 80,000 or 120,000 cubic ft. of gas per hour.

A good burner of this type provides its own primary air which amounts to 60 per cent. of the air necessary for combustion. The secondary air, which is just as essential, is drawn in by the chimney draught, in conjunction with the injector action of the mixture emerging from the burner nozzle. The maximum flame temperature should be found in the region of the boiler within a few feet of the burner, and there should be a minimum volume of flue gases carrying away heat to the chimney.

2. Intermittent gas pressure is found at most ironworks having no gas-cleaning plant. Each time a bell is lowered to admit the charge into a blast furnace, the gas pressure drops and usually the gas fails altogether. Ordinary Bunsen-type burners are useless under these conditions. They light back at the gas inlet inside the mixing tube, and each burner requires attention from the boilerman every time the pressure falls—say, every 10 minutes—an impossible proposition. It is only very recently that this problem has been solved by the use of special burners. In these burners when the gas pressure falls the gas burns at that point where the speed of the gas-air mixture corresponds to the speed of the flame. When gas fails, the flame is extinguished and a small coal fire is kept in the boiler to ignite the gas when it returns. As soon as gas pressure returns, the velocity of the gas-air mixture forces the flame out of the mixing tube and combustion continues at the burner nozzle as before.

3. To deal with gas at a very low gas pressure, and to get a good mixture of gas and air, is impossible without mechanical assistance. The problem can be solved in two ways: (a) Air and gas can be drawn in by means of a fan, mixed completely in the fan, and the mixture supplied to the boiler by a simple pipe ; or (b) power to work a Bunsen-type burner can be got by raising either the gas or the air to a sufficient pressure. Although both these methods are costly, the results, both as to additional boiler load and as to improved efficiency, are so satisfactory as to pay many times over for the outlay.

When a short, intense flame is required, we must use either air or gas under considerable pressure. This method is well known in the case of gas furnaces for reheating and melting. From $1\frac{1}{2}$ lb. to 2 lb. per square inch pressure on the air supply is the most suitable pressure, though excellent results are got with 12 in. (water gauge) pressure. The whole of the air needed for combustion is supplied by the mixing arrangement, no secondary air being used. The author believes that by this method, which puts the boiler under pressure, and by simply drawing off the products of combustion by the chimney draught, we should make a considerable advance in the direction of larger boiler outputs combined with high efficiency.

Preheated air and hot gas are of great advantage for boiler firing. Air preheated to 190° C. was used at one plant, with producer gas of 150 therms per cubic foot. The sensible heat of the air added 5 per cent. to the calorific value of the gas, and thus raised the flame temperature. It depends upon where the heat is got, whether it really adds anything to the total efficiency.

GAS MEASUREMENT.

If the evaporation of a boiler is known, the only other thing required is to know the quantity of gas consumed. Here a serious difficulty arises. Where a large quantity of gas is concerned, measurements are difficult, and where the gas is of high and varying temperature and carries a large quantity of dust, they are next to impossible. For large quantities, and where there is difficulty from the dust, gas velocity measurements, with the assistance of the Pitot tube and a differential draught gauge, or manometer, can be taken. Velocity readings given thus cannot be trusted to give absolute readings, but they are [illegible] readings which are relatively correct from day to day.

Certain points require to be watched when using gas meters unless the gas is quite free from dust and tar. A meter of the rotary type should be calibrated by means of a gasometer, both before and after use, [illegible]. The Pitot tube must be kept clean, and should be examined and blown out at short intervals.

BOILER CONTROL.

There are three methods by which we can test what results are being got by a boiler, namely, (1) by measuring the gas supplied and the water evaporated ; (2) by analysing and taking the temperature of the waste gases, as described above ; and (3) by taking the combustion temperature. All these methods are good. The chemical method is slower and more laborious than the pyrometer method, but it is cheaper and gives much more information.

For testing the combustion temperature a pyrometer junction is inserted in each boiler flue within a short distance of the nozzle of the burner. All these junctions can be wired to one dial, with switches to connect each junction in turn to the dial.

A CO_2 recorder on the boiler flue is an excellent check on the results. It will be realised, however, that very deceptive deductions may be made from the readings of this instrument. Although the CO_2 reading is good, there may be unburned CO present, causing serious losses. A gas-pressure gauge should be fitted, if not at each boiler, at least at every range, and that it should be in a place easily seen by the boilerman. In addition to this, a differential draught gauge should be fitted to each boiler, showing the difference in draught between the front and back of the boiler, and a plain mark should be made on the dial at the reading which the boilerman is to maintain by means of his dampers. Water meters are a necessity for careful boiler control. In all large works a man should be appointed to take general charge of the steam output. He need have no great chemical or engineering training, as his business is simply to run his boilers at their maximum efficiency, and all engineering matters would be reserved for the engineer or manager. The apparatus for boiler control will cost a considerable amount, and it must not be overlooked that the best outfit of recording instruments is useless unless a constant and intelligent use of them is absolutely enforced. All the temperatures, pressures, volumes, and analyses taken, should be entered up in a special book. At least once a week a balance sheet should be drawn up, showing the allocation of the gas to each part of the work and the results obtained therefrom. This should be submitted to the manager weekly, with the necessary explanation in case any result falls short of the required efficiency. If, in addition to this, the boilermen and the man in charge of the boiler plant are given a premium for maintaining good results, boiler control will soon develop into a fine art, and prove an important source of revenue.

The Paper is followed by an appendix giving a number of calculations and useful tables.

DISCUSSION.

Mr. C. P. SPARKS said he had rather hoped that the author would have devoted more attention to how the gas was to be obtained as distinct from its use. The majority of electricity was obtained by burning fuel and the whole of the volatiles were destroyed. It was a national necessity that that method of procedure should stop. The chemical industry was dependent on those so-called by-products. Coal distillation was carried out in connection with coke production, in which the gas was a by-product, and in gas making, in which the coke was a by-product. Then there were various projects of low temperature distillation where new types of fuel were to be produced for household purposes, and there again the gas, tar, &c., were by-products. Should the electrical stations be put at the coke ovens, or work in conjunction with the gas companies, or should they await the development of the domestic fuel schemes? The Fuel Research Committee were going to look at the question from the point of view as to how best the coal of the country could be used for all the objects he had mentioned. There were also a certain number of important commercial undertakings which were making their own investigations into that matter. Coke manufacture for steel work took place primarily at the pits, and the pits had attracted large industries to their neighbourhood, but in most cases there was a great difficulty with regard to water. Having got the gas he thought the most economical method of using it for electrical supply was to turn it into steam and work in conjunction with very large turbo-alternators. Gas undertakings were usually near the centres of distribution and the co-operation of electricity and gas undertakings would, as a rule, tend rather to work on the present lines of centralisation of small undertakings than in the now well recognised direction of having larger areas.

Mr. W. B. WOODHOUSE said the most important point in gas firing was the regulation of pressure. Gas was particularly sensitive to variation in the mixture of air and gas depended on how much air the gas would entrain into the burners. The calorific value the author gave for [illegible] seemed rather high. The statements regarding the use of [illegible] and blast furnace gas were very rosy. He (Mr. Woodhouse) thought the proper basis for consideration was not how much gas was obtained per ton of coke put into the blast furnace, but how many thousand cubic feet per ton of iron and what was the heat value. One could hardly regard as surplus gas that which was used for blowing and for the stoves. The important question was how much remained over after the process of producing pig iron had been carried out. He calculated that the equivalent coal value of the surplus was 1s. 6d. per

ton of pig-iron produced. Mr. Hunter said by-product producer gas, which in heat value was equivalent to blast furnace gas, had not proved a success. It was difficult to get successful boiler firing with gas containing so much inert gas as producer gas, but it could be done. The author assumed an efficiency for producers and then took the amount of heat required for steam raising, which was a part of the process of producing gas. What they wanted to know was the total heat value of the surplus gas after the processes necessary for working the producer had been carried out. The author referred to dry gas. If he meant merely saturated gas, then he (Mr. Woodhouse) understood his figures, but if he suggested that the gas should be dried and unsaturated it would not be worth the trouble. If before using the gas it was reduced to atmospheric temperature or lower, a more efficient result would be secured, but a certain amount of heat would be lost in cooling the gas, and if the gas was to be dried money or power had to be spent in doing so.

Mr. E. W. L. NICOLL said he associated himself with the remarks of Mr. Sparks in reference to the necessity for recovering all the recoverable products from the coal before it was used for steam raising. The author remarked that gaseous fuel was an ideal fuel, and, that being so, he (Mr. Nicoll) thought it was too good for boiler firing. The surplus combustible residual of coal carbonisation was coke, and it always would be. The present need was the development of coke fired furnaces for steam generation on a large scale. An enormous quantity of sensible heat was wasted. The coke was extracted from the retorts at a temperature of about 1,800°F. The use of that sensible heat would mean close co-operation of the electricity and gas industries. The steam plant for the steam turbines would have to be put down actually in the gas works. It would only be a step added to the present gas-works practice to dump the coke into the boiler furnace. The problem of gas firing boilers on a large scale was a serious one. For a station of 100,000 kw. taking the low figure of 30,000 B.Th.U. per unit generated with producer gas at 130 B.Th.U. per cubic foot, 23,000,000 cubic ft. of gas would have to be transmitted per hour, and the tube necessary to transmit it would have to be of the order of a "twopenny tube." He thought the use of coal gas would also be out of the question.

Mr. H. W. KOLLE said he proposed to confine his remarks to blast-furnace gas-firing, about which the author's remarks were rather too roseate. One of the difficulties of blast-furnace gas firing was that there was a constant variation on the gas main. It was difficult to adjust the air supply to the gas supply under anything like theoretical conditions. In blast-furnace gas about 30 per cent. was combustible and 70 per cent. incombustible. The oxygen in the air had to seek out the combustible and that required a good deal of excess air [illegible] than the author's figure of 25 per cent. He thought 100 per cent. was more general. Usually in practice the air regulation was set once for all and few blast furnaces had any apparatus for continuously recording the CO_2 in their gas. When one had that 100 per cent. excess, the air was practically adjusted for the maximum quantity of gas that was to flow, otherwise there would be at times secondary combustion. It was not easy to carry out well conducted efficiency tests on gas-fired boilers with blast furnace gas. In most cases the gas was dirty and could not be measured through a meter, and one had to rely on Pitot tube readings, which were fluctuating and varying. He did not think there was an installation in this country where they had any means of regulating the blast furnace gas-pressure. It was an open question whether much was gained by cleaning the gas before using. Another [illegible] was to use the gas at the low pressure at which it left the blast furnace. In blast furnace works, as in electricity stations, people were [illegible] and short sighted. In an installation where 250,000 tons were being burnt a man was paid £400 to £600 a year for looking after the boilers, and it was considered a big figure, but a man paid £1,000 could pay for himself many times over. With producers the gas was produced solely for the purpose of burning it, and a regular pressure on the mains could be obtained and burners could be arranged to give a high efficiency, and with coke oven gas a high efficiency could also be got.

Mr. J. D. Pyres said he noticed the author's [illegible] of the value of carbon monoxide. The modern trend of distillation was the [illegible]

[illegible]

Mr. W. H. Casmey thought that the Paper [illegible]

was [illegible] Published results [illegible] gave all sorts of information except the quantity of gas used. This, of course, was vital. [illegible] ally being a waste product, but if coal carbonisation were to come in seriously, efficiency would then be very important, and it would be necessary in all tests to have the fullest information in regard to both the quantity and the quality of the gas. With regard to the design of boilers it seemed to him that [illegible] utilisation of radiant heat in gas firing if the best results were to be obtained. Some reference had been made to the use of coke. It appeared to him that commercial progress in carbonisation must depend largely upon realising the value of by-products, among which ammonium sulphate played a large part. If the coke from carbonisation were used under boilers, then the large proportion of nitrogen which remained in the coke would be wasted. Complete gasification, therefore, showed an advantage from this point of view, and low temperature carbonisation was attractive [illegible] producers.

Mr. W. H. PATCHELL thought the author had overdrawn some of his statements. The whole question of boiler firing centred round what it cost to get the by-products. Coke was a bad fuel, but, if it could be dealt with economically in a producer it would meet their need. The author said the ordinary blowing did not take more than 1 H.P. per ton of fuel, but these blowers were not economical in steam, and 30 lb. per horse-power-hour should be allowed. With recovery producer gas the temperature had to be kept down so that the sulphate of ammonia was not lost. The radiation of 1½ per cent., which the author gave them when dealing with boiler efficiencies, was rather lower than was generally accepted. The Paper might usefully have contained a cross reference to "The Electrician," of June 15 of this year, which contained descriptions of various types of burners.

Mr. J. H. HIGHFIELD said it was well known that large quantities of heat were going to waste, and one of their first objects should be to collect all the forms of waste heat and turn them into electricity, which, so far as they could see offered the best way of making use of those sources of heat. He gave figures—not ascertained figures, but the kind of figures required—comparing the net cost of fuel for producing 900 units, (1) by using the coal first in the producers and then burning the gas under the boilers, (2) by burning the coal under the boilers, and (3) by putting the gas into a gas engine. In the first case the net cost of fuel was put at 15s., in the second 20s. and in the third 12s.

Mr. A. H. DYKES said practically the whole question as to how electricity was going to be used in the future depended upon this question of using the gas for boiler firing. Waste gases would have to be utilised and the larger question of new stations for power supply would also have to be considered and decided by electrical engineers in conjunction with the chemists and metallurgists. A subsidiary advantage of working with the chemical side of the industry would be that they would require less manual labour and could afford to pay more for skilled chemical and engineering supervision and there would also be a saving by abolishing the clinker and ash plant.

Mr. C. P. TAYLOR said the figures in the Paper relating to the efficiency of producers required [illegible] throwing away 30 per cent. of the value of the fuel was that the sulphate of ammonia was obtained. It would be less advantageous to adopt gas firing unless the price of sulphate of ammonia went up in proportion to the increase in the price of fuel. In connection with a small power distribution scheme recently, he found that gas could be distributed more cheaply [illegible] energy.

Mr. L. B. Atkinson [illegible] of ammonia [illegible] the sulphate of ammonia market themselves by the production of nitrates by electrical processes [illegible] hitherto would not obtain in the future.

Mr. H. M. Sayers [illegible] blast furnace gas by [illegible] a scrubber on those lines.

[illegible] any special work but were given to [illegible]

[illegible]

The Electrician.

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GAS-FIRING OF BOILERS.

Last week Mr. T. M. HUNTER read a very interesting Paper before the Institution of Electrical Engineers on the subject of Gas-Firing. We think the Council have done well in arranging for a Paper of this kind, which is not strictly upon an electrical subject; for electrical engineers are quite as much concerned with the production of steam as with the performance of electrical generators. The production of steam and the proper methods of utilising fuel are only two of the steps in the chain of operations in supplying electrical power, and it is quite as important that the electrical engineer should be thoroughly acquainted with what these first steps involve as that he should be familiar with the remainder of the subject. At the present time gas-firing is something of a side issue. It is used where gas is available, but not because it is necessarily a desirable method of firing. In the near future, however, the position may be very different. At the present time, as is well known, there is a strong move in favour of dealing with our coal on scientific lines, recovering the nitrogen and oils that are in it instead of simply burning these constituents along with the coal. If this mode of utilising our coal comes into vogue then the position of gas-firing will be entirely altered. Electrical engineers may then find it not merely desirable to use gas firing, but they may even be compelled to do so. It therefore behoves them to look into the position very carefully and to study the question so that they know what results are obtainable and what are the best conditions of operation.

Mr. HUNTER's Paper, of which we conclude an abstract in our present issue, is very useful in that it gives a great deal of information and deals with the subject in some respects in an elementary way, so that those who are not already well acquainted with it may be able to appreciate the present position. Readers will realise that the subject is by no means free from difficulties. As so often happens, there are conflicting conditions, and the best results are often only obtained by means of a compromise. This is the case to some extent in boiler design. Probably a good deal yet remains to be done by the boiler maker before the most suitable boiler is produced for gas firing, as distinct from coal firing.

Undoubtedly one of the most pressing directions in which information is required is in the working efficiency of gas-fired boilers. Unfortunately, the determination of the efficiency of a boiler when gas fired is far more difficult than when coal fired. The measurement of large volumes of gas is by no means so easy, and consequently in most tests it has been entirely disregarded. This state of affairs has been favoured by the fact that the gases used are frequently waste gases, such as blast furnace gases, or are by-products, such as the gas obtained from coke ovens. Consequently, whether a little more or less was used has not been important and the careful measurement of the gas has been neglected. This state of affairs, however, will be changed if carbonisation comes into general use. It will then be just as necessary to work with a proper regard to efficiency as in the case of coal fired boilers. Thus it will be essential to measure large volumes of gas with a reasonable degree of accuracy and also to determine its average calorific value, and not to depend upon odd observations of its thermal value. This will be so not merely in test runs with a view to taking over plant from contractors, but also to a large extent in ordinary running. Just as a Lea recorder is now commonly used in power stations to check the steam consumption so will it be necessary to have proper appliances for measuring the gas, thus ensuring the most efficient performance of the boilers. It will then be quite as necessary to measure the gas as it is now to weigh the coal.

Unfortunately, gas meters of the usual type cannot be universally applied. They are suitable where the gas has been cleaned, but in many cases (for example with producer gas) dust and tar may be present sufficiently to prevent satisfactory working of the meter. Undoubtedly, in many ways it is preferable to use an indirect method, such as the Pitot tube, or a meter depending upon differences of pressure, but the disadvantage of such methods is that the force with which one is dealing is small, and high accuracy is not easily attained. It is clear that there is considerable room for the investigator to devise suitable means for solving this problem.

REVIEW.

High-Speed Internal Combustion Engines. By A. W. JUDGE, A.R.C.Sc., D.I.C., Wh.Sch. (London: Messrs. Whittaker & Co.) Pp. ix.+350. 15s. net.

This volume, which is one of Messrs. Whittaker's Specialists Series, contains the results of most of the experimental research of recent years on internal combustion engines. The illustrations are clear, the type used is such that the subject matter is easily read, and although the book contains only 350 pages of matter the excellence of its get-up justifies the price asked for it.

The subject matter is divided up into seven chapters, which deal with thermodynamics, explosion and combustion, conditions occuring in actual engines, pressures and temperatures, indicators and indicator diagrams, mechanics of the high-speed engine and engine balance. It can be readily seen that the first five chapters deal with the actions taking place within the cylinder, &c., and that the last two chapters have to do with the dynamics of the petrol motor.

Reference to the index shows that the author is thoroughly conversant with the work done by the Committee of the British Association on Gaseous Explosions, as practically each member of that Committee is named and his work referred to in the text. This book brings its subject matter up to immediate pre-war date; there has been much good work done since then and advances made which it is hoped the author will give us in the second volume promised in his preface, a volume which is to deal with high speed engine design.

In most books on internal combustion engines the first chapter deals with thermodynamical laws, and the algebraical proofs of equations necessary to the adequate understanding of the succeeding chapters. In this volume the theory is carried beyond the usual stage and the effect of the variability of specific heats upon calculations is clearly worked out; also the effect of variable specific heats upon the standard cycle efficiencies is shown algebraically in a manner useful alike to teachers and students of heat engine theory. There are in this chapter eight tables of data, and in every case save one the results are expressed in degrees Centigrade. In Table IV. the author speaks of LB degree Cent. units, yet on page 1 there is no mention of this heat unit; the place of honour is there given to the B.Th.U. and to degrees Fahrenheit, and the pound calorie not even mentioned; also on page 3 the specific heat of a gas is defined as "the quantity of heat required to raise unit mass of the gas through 1° of temperature"; agreed,

but why does the author add that "the pound and Fahrenheit units are usually employed"? Is not the numerical result the same as for the pound-centigrade system? The title page of the book shows that Mr. Judge has been associated with both Profs. Callendar and Watson at the Imperial College of Science, and therefore it was to be expected that the pound-centigrade system would be used by the author throughout, with perhaps an apologetic reference to the Fahrenheit system, and that the value for J would be given as 1,400 ft.-lb. Apart from the gas making industry the B.Th.U. is a unit that is gradually dying, in England at any rate, and thus it is a matter of regret that the author employs it, and the Fahrenheit scales in the first three pages, and then afterwards nearly always refers to temperatures in degrees centigrade.

Chapter I. ends with a description of the temperature-entropy diagram and its use in virtue of its being more readily analysed for calculation purposes than the corresponding P. V. diagram. A foot-note to page 52 referring to a Paper by Mr. W. Goudie and published in the "Proceedings of the Institution of Mechanical Engineers," would be useful to any who have to make a $T-\varphi$ diagram from an indicator card. The matter of Chapter I. is very well written and ought to be in the hands of all engineering Honours students for careful study.

Chapter II. is an [illegible] of the work done by Profs. Hopkinson, Watson, Callendar and Dr. Dugald Clerk on explosion and combustion of gaseous fuels, and in Chapter III. the conditions which make for efficiency in the actual engines are discussed. It would have been interesting if the author could have given some more light-spring indicator diagrams showing the effect of speed and richness of charge on the exhaust pressure line on page 175 and thus amplify his remarks on the effect of throttling upon efficiency.

Chapter IV. gives the results of Profs. Callendar, Dalby and Coker's measurements of the cyclical temperatures which occur in actual working, and in Chapter V. are given descriptions and illustrations of some of the best optical methods of taking indicator diagrams when running at high speeds: surely it was an omission not to have mentioned the indicator designed by Prof. Dalby and illustrated in a paper read by him before the Institute of Naval Architects.

The two concluding chapters on mechanical running make a well written finish to an [illegible] volume, and it is [illegible] to see the references to the designs of Mr. Lanchester. This book can be recommended as a work to be on the shelf of every scientific engineer who has to do with the design of petrol motors, and in the library of every engineering college.

A. J. Margetson.

THE NITROGEN PROBLEM AND THE WORK OF THE NITROGEN PRODUCTS COMMITTEE.

The Nitrogen Products Committee of the Ministry of Munitions was formed over a year ago under the [illegible] of the Munitions Inventions Department and has been conducting a confidential and exhaustive inquiry into the nitrogen problem. The difficulties confronting the inquiry of the Committee were considered to be of such a nature that little in the way of practical results might have accrued; so far, however, from this being the case, the progress made and the success attending the [illegible] research work that has been undertaken foreshadow the possibility of developments of permanent value to the country. A statement has now been issued, from which the following information is taken.

The Committee is constituted as follows:—

Col. H. E. F. Goold Adams, C.B., C.M.G., R.A. (Comptroller of the Munitions Inventions Department, Chairman), [illegible] Mr. [illegible], M.A. (Chairman of the Processes Sub-Committee), W. R. Cooper, M.A., B.Sc. (representing the Physical Society; Chairman of the Gas Firing Sub-Committee), Sir James Dobbie, D.Sc., F.R.S. (representing the Board of Agriculture and Fisheries; Chairman of the [illegible] Sub-Committee), Prof. A. K. Huntington, A.R.S.M. (representing the Faraday Society; Chairman of the Experiments Sub-Committee), Sir John [illegible] Snell, M.Inst.C.E. (representing the Institution of Electrical Engineers; Chairman of the Power Sub-Committee), W. R. [illegible], K.C., F.R.S., Charles C. Carpenter, D.Sc., Kenneth M. [illegible], M.A. (co-opted), Prof. J. Norman Collie, D.Sc., F.R.S., [illegible] A. W. Crossley, D.Sc., F.R.S. (representing the Chemical Society), Prof. [illegible] Donnan, M.A., F.R.S., Sir Arthur Duckham, K.C.B., R. C. Farmer, D.Sc. (representing the Explosives Department), F. [illegible] (representing the Board of Trade), J. A. Harker, D.Sc., F.R.S. (Director of Nitrogen Research Section), [illegible] M.Inst.C.E. (co-opted), [illegible] of [illegible], G.B.E., K.C.B., F.R.S. (Director-General of Explosives Supply), C. H. [illegible], M.Inst.C.E. (co-opted), [illegible] M.Inst.C.E. (co-opted), E. J. Russell, D.Sc., F.R.S., [illegible], M.A., F.R.S., Sir R. Threlfall, K.B.E., F.R.S., and [illegible] K.C., M.A. ([illegible] on the Board of Trade Committee on Electrical Power Supply). Secretary, [illegible]. Assistant Secretary, [illegible] H. W. [illegible].

Nitrogen is an essential constituent of practically all modern explosives, both of the [illegible] and of propellants. It is also an essential constituent of all [illegible] and the world's production of food is becoming more and more dependent upon the [illegible] of [illegible].

With the outbreak of war, the demand for explosives [illegible] paramount importance [illegible] of supplies [illegible] [illegible] [illegible] of food [illegible] the [illegible] of the [illegible].

[illegible]

[illegible] processes, some of which were established commercially before the war, have been [illegible].

In February, 1916, a memorandum on the nitrogen problem was submitted to the Munitions Inventions Department by the Faraday Society. Several conferences were held to discuss the steps that should be taken, and as a result, the Nitrogen Products Committee was constituted in the following June. Members of the [illegible] Panel, representatives of other departments of the Ministry of Munitions and of the Government, and delegates of the leading scientific societies were invited to serve. Briefly, the work of the Committee was to consider the relative advantages of the various methods of nitrogen fixation, to [illegible] the supply of raw materials, to consider the [illegible] on the problem, to consider what steps could be taken to conserve nitrogen-bearing compounds, to carry out such experimental work as might be necessary, and to advise as to [illegible] operations on an industrial scale.

The following sub-committees were set up: Processes, [illegible], Experiments, Power and General Purposes. At a later date another sub-committee was found necessary to deal with the question of coal distillation processes and the production and utilisation of power gas. The Gas Firing Sub-Committee was accordingly constituted. In all, the Committee and its sub-committees have held upwards of 80 meetings.

The necessity for research [illegible] and the Department [illegible] for the [illegible] of a suitable research staff and the [illegible]. [illegible] the co-operation of the authorities of University College was secured and a part of the new Ramsay Laboratory, at that time scarcely completed, was placed at the disposal of the Department. [illegible]

[illegible]

[illegible]

[illegible] Munitions [illegible]

[illegible]

also recommended that action should be taken to avoid the loss of ammonia known to be occurring in certain districts.

(*b*) *Ammonia Oxidation Process.*—The erection at the earliest possible moment of plant capable of producing in the aggregate at least 10,000 tons of nitric acid per annum from gasworks or coke-oven ammonia was recommended.

(*c*) *Cyanamide Process.*—The erection of a factory having an annual output of the order of 50,000 tons of cyanamide was recommended, the cyanamide to be utilised as such for agriculture or for the production of ammonia.

(*d*) *Synthetic Ammonia Process.*—The erection of a full-sized trial unit plant for the synthetic ammonia process was recommended.

The Minister's Decisions.

The Minister of Munitions invited members of the Committee to meet him, and the recommendations of the Interim Report were discussed in detail. At the conclusion of this meeting the Minister appointed a small executive committee to supervise the action involved in giving effect to his decisions, and to report to him from time to time upon the progress made.

The Minister's decisions were as follows :—

(*a*) *By-product Ammonia.*—The Committee was requested to deal with the problem of conserving ammonia and of augmenting the output on the lines of the recommendations.

(*b*) *Ammonia Oxidation Process.*—The Ministry of Munitions would undertake the installation of one Government plant on the lines suggested, or, if the Committee so advised, the Ministry would agree to the erection of plants by suitable private firms. The information resulting from the research work was to be placed freely at the disposal of *bona fide* manufacturers, but was not to become the exclusive property of any firm or group of firms.

(*c*) *Cyanamide Process.*—The Committee was requested to investigate the relative merits of a Government scheme and of other schemes that had been put forward involving private enterprise, and to submit a report embodying definite proposals.

(*d*) *Synthetic Ammonia Process.*—The erection of the full-sized trial unit was authorised.

In carrying out these decisions the Executive Committee dealt first with the problem of conserving and increasing the output of by-product ammonia. The co-operation of the Controller of Coal Mines, of the gas companies and of the domestic and industrial users of coke was enlisted, and the matter was then placed under the direction of the Explosives Department in March, 1917, in view of its existing organisation for dealing with the supply of ammonia.

The next step taken was to summon a conference of manufacturers likely to be interested in the ammonia oxidation process. Several manufacturers at once agreed to take up the further study of the process with a view to its commercial development.

With regard to the manufacture of cyanamide, the Executive Committee came to the conclusion that the schemes involving private enterprise did not adequately fulfil the ends in view and recommended the erection of a factory by the Government. The Committee proceeded to collect further information on cyanamide processes in actual operation, and representatives proceeded overseas for this purpose. Complete details of a scheme involving a large-scale factory with electric power station are now in course of preparation for submission to the Minister of Munitions.

Meanwhile a considerable amount of work had been carried out in connection with the synthesis of ammonia, including a detailed investigation of the whole of the conditions governing the process, and of the efficiency and life of numerous catalysts. These studies led to the devising of a method of working whereby the output of ammonia per unit of catalyst space has been increased to a figure, which, as far is as known, exceeds anything hitherto attained.

The Importance of Cheap Electric Power.

It was realised from the outset that the generation of electric power at a cost decidedly lower than has hitherto been attained in this country was a vital factor if an attempt was to be made to establish certain of the nitrogen fixation industries in Great Britain on a sound economic basis from the point of view of post-war competition. A thorough inquiry has therefore been made as to the possibility of cheapening the production of electric power from coal, not only by its generation in bulk with the most modern plant, but also by the use of methods involving carbonisation and gasification, with recovery of the ammonia, fuel oils and other by-products hitherto wasted when raw coal has been directly used. The sub-committees concerned have had the advantage of obtaining the personal views of a number of experts who attended to give evidence on different aspects of the problem. This inquiry has been distinctly fruitful, and much detailed information has been collected.

Schemes for the utilisation of various undeveloped water-power in the British Islands for nitrogen fixation have also been submitted and have been carefully examined. At least one of these schemes for hydro-electric development on a considerable scale presents *prima facie* prospects of becoming a valuable national asset.

SCIENCE AND ITS FUNCTIONS.*

BY A. A. CAMPBELL SWINTON.

In considering what subject I should choose for my address on this occasion I have been mindful of the objects of the Society which, as you know, exists for the encouragement of arts, manufactures, and commerce.

Now, as I propose to show you, what is at the base of all the arts, as also of all manufactures, and as commerce consists of dealings in these manufactures, at the base of all commerce as well, is Science. Huxley has defined "science" as "trained and organised common sense."

Of all scientific inventions perhaps the one, and a very simple one, too, that has most influenced the history of the world is that of printing. When there began in Europe that great revival of learning known as the Renaissance, it was the printing press that became its principal coadjutor, and caused things to move at a rate [illegible] on a scale larger than ever before.

To give you some measure of the vast changes that have been brought about let us consider how matters stood [illegible] years ago, say in [illegible], the year in which our Society of Arts was founded. At that date the steam engine had not yet assumed a practical form, and apart from some small use of water and wind power, when mechanical work had to be done this was accomplished by the aid of the muscular effort of men and animals. The question of power supply was, in fact, in the same condition that had existed for thousands of years. The steamship was unthought of, and ocean journeying was [illegible], and but little more certain, than in the days of Columbus. Railways, in the modern sense, were non-existent, and even the coaching era had scarcely begun. Travelling of all sorts was no more rapid or more convenient than in the days of the Romans. Illuminating gas and electric light had still to be invented, public lighting was practically non-existent, and even in London and other large cities, linkmen with torches were required to light the passenger to his home after dark. Printing was slow and expensive. Nor were there any proper systems either for water supply or for the disposal of sewage. Disease, born of filth and neglect, stalked through the land practically unchecked.

To-day we live altogether in a different world. Many great inventions with which we are now familiar are younger than our Royal Society of Arts.

It has been the fashion to divide what we understand by science into two portions, pure science and applied science; but these are only halves of one great whole. Even great scientific discoveries have in some cases been made by chance, but generally only by men of marked intuition and acutely developed powers of observation. The results of research are cumulative, one discovery almost invariably leading to others in course of time. Moreover, all discoveries in pure science, however recondite and however seemingly useless at the moment, find their practical application sooner or later. It is a noticeable and curious fact that many great inventions have been made by men whose ordinary vocations were quite outside the particular field in which their inventions applied. This is no doubt a case of the fresh mind of the outsider looking at things from a new aspect, whereas those who are daily working in any particular line are apt to get into a groove. Perseverance, and a capacity for continuity in keeping to one subject, are outstanding qualities to be observed in all successful inventors. Great discoveries, however, are never, and great inventions very seldom, the work of a single individual. At certain periods, the general state of progress, both in pure and in applied science, renders particular inventions possible, with the result that a number of persons gifted with the necessary imagination almost simultaneously attack the problem. In such cases if one individual inventor had not succeeded, it is probable that another would have done so.

* Abstract of Inaugural address to the Royal Society of Arts.

The history of particular inventions is frequently instructive, and a good instance is that of wireless telegraphy, which is comparatively recent, so that we know all about it, and can follow accurately each single step in its development. Clerk Maxwell's discovery in 1870 that light was an electro-magnetic phenomenon, lay purely in the land of theory, discovered mathematically, and he attempted no experimental proof. Some 20 years later Hertz, by a series of most beautiful experiments, proved the truth of Maxwell's theory, showing how electro-magnetic waves could be reflected and refracted, and, in fact, obeyed all the laws with which light is known to comply. Up to this stage nothing in these investigations had hinted even in the slightest degree at any useful application. Hertz died young, but his work was taken up and largely extended in this country by Sir Oliver Lodge, who threw out the suggestion that the Hertzian waves might possibly be employed for signalling. Yet nothing practical was done until Mr. Marconi, who was acquainted with the work of both Hertz and of Lodge, and was impressed with the possible commercial value of the idea, came upon the scene, and with great skill very soon showed that it was feasible by Hertzian waves to telegraph across the Channel, and even over much longer distances.

The subsequent history of wireless telegraphy likewise shows how researches and experiments in pure science, which, so far as their authors could see, showed not the faintest sign of any practical application, led in time to inventions of the greatest possible public utility. Many years elapsed between the researches and theories of Young and Maxwell, the experiments of Hertz, and the advent of practical wireless, and, when it came, all the three original investigators were dead; yet, unless these three great men had evolved their brilliant ideas and worked them out as they did, wireless telegraphy had never been.

Equally striking no doubt, will be the future results of the developments in our knowledge of molecular physics during recent years, such as the contributions of Sir Joseph Thomson and his Cambridge school of experimenters on the nature of atoms and nuclei of electrons.

Now to those who have not studied the question all this must seem very remote from the practical politics of applied science, such as we make use of in our daily life. But it is not so, for it is to these almost infinitely small negative electrons that we owe the Röntgen rays.

Again, academic discoveries about the electrical structure of the atom, and the properties of its constituent parts, have also borne practical fruit in other directions, as, for instance, in what is to-day much the most sensitive and reliable apparatus for receiving wireless telegraph signals, and in an entirely novel form of chemical analysis recently applied by Sir Joseph Thomson. Any way, we see how in a space of only about 20 years, discoveries of apparently purely academic interest, in perhaps the most abstruse of all lines of scientific investigation, are already beginning to be usefully applied.

An interesting question is what manner of men they were who made our great scientific discoveries. An outstanding feature is that many of them had no professional connection with science at all, but were amateurs pure and simple. Among these may be mentioned Robert Boyle, the famous discoverer of the law of the expansion of gases, who was a landed proprietor educated at Eton. Henry Cavendish also, who discovered hydrogen and the composition of water, and did much [illegible] work in electricity, besides devising the celebrated Cavendish experiment for ascertaining the weight of the earth, was a pure amateur. Sir William Herschell, the famous astronomer, was by profession an organist and a teacher of music. Priestly, who discovered oxygen, was a Presbyterian minister. Dalton, [illegible]. Benjamin Franklin, a self-educated printer. Count [illegible] life as an assistant [illegible].

[illegible]

[illegible]

Alexander Graham Bell, the inventor of the telephone, a teacher of the deaf and dumb. Edison, a railway newsboy, practically self-taught. William, afterwards Lord, Armstrong, the inventor of hydraulic power distribution, and celebrated for his gun, a practising solicitor till he was 35 years of age.

Thus inventors are born and not made: in numerous cases genius can dispense with teaching from outside. In fact it is not for men such as these that more education in science is to-day wanted, but rather for our masters, the politicians, the directors of public affairs, and the Government officials.

We hear at present a great deal about the avarice of capital and the extortionate profits of monopolists and patentees. It is unfortunate that in this country of late years it has become a fashion to consider the making of large profits as almost a crime. Yet the working out of many industrial scientific processes and inventions can only be accomplished by great and prolonged expenditures, and the risking of vast sums of money, such as only very rich persons or companies can afford.

There are two methods by which people acquire wealth. In one case they transfer other people's wealth out of these people's pockets into their own; in the other case they actually create wealth that did not previously exist. Now one of the functions of science is to create that best of all descriptions of wealth, increased productivity, which it does through discovery and invention, and the enhanced command that man thereby obtains over nature. Thus the invention of the steam-engine by James Watt, and the three or four other men who were associated with him in that vast development, must have increased the wealth of Great Britain and of the world by many hundreds, if not thousands, of millions sterling. Other inventions great and small all operate in a similar manner. Both those who make discoveries and those who make inventions are well worthy of their hire, and it is seldom that they receive as remuneration for their work more than the merest modicum of the wealth that they create.

This brings me to another point in connection with invention, and that is the injustice and the inexpediency, from a public point of view, of the present system whereby the Patent Office makes a large annual profit out of the fees paid by inventors. There might possibly be some justification for this were the money thus obtained spent on scientific education, on scientific libraries, or on some other object that would further invention and discovery. The money is, however, merged in the ordinary revenues of the country. It is, moreover, a tax on the cerebral activity of a class of men who are usually by no means overburdened with wealth.

We shall however, never get justice done to science by the Government and its departments until some knowledge of [illegible] compulsory part of the curriculum for the training of the Civil Service, and an important item in the entrance examinations. Only in this way shall se get the departments filled by men who realise what science means, and [illegible] progress. There is an idea afloat in the political world, as also in the bureaucratic mind, that no man can at the same time be a master of science and a good administrator or organiser, either in public or commercial affairs. [illegible] Benjamin Franklin and [illegible] [illegible] of large industrial enterprises.

[illegible]

BOOK RECEIVED.

[illegible]

CORRESPONDENCE.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to Mr. C. H. Wordingham's presidential address and your editorial thereon in your issue of the 16th inst., may I suggest that the representation on the Council of the various sections of the members (which object both you and he desire to attain) would be carried out most satisfactorily by the adoption of the system of proportional representation. Under this method any section amounting to one-twelfth of the membership would, with the present constitution of the Council, be certain of electing one member, and larger sections would be sure of their fair proportion. At present the representation of even the larger sections is chiefly a matter of chance.

The drawback of any scheme of sectional representation such as the President appears to have in mind is that even if it is fair when it is established it makes no allowance for possible changes in the relative numbers in different sections. P.R., on the other hand, automatically alters the representation to suit any such changes or the arisal of new sections. The method of voting is quite simple, and although the counting of the votes is more complicated than the present one, it would present no difficulty to any competent engineer.—I am, &c.,

[illegible], Nov. 25. W. TOLMÉ MACCALL.

FACTORY ELECTRIFICATION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your last issue the sub-station equipment of the Manchester Co-operative Wholesale Society is described and illustrated, and although the pictures may be "very pretty," am I to assume they are intended to illustrate how a modern [illegible] sub-station should be laid out?

From the description it is apparent that all the generators run in parallel, and in the illustration we see a switchboard claimed to be "an excellent example of modern practice," which must occupy a huge floor space and have been very costly; seven panels are devoted to the control of seven motor-generators. Why seven? We all, I hope, are aware that there are seven days in the week, but this cannot surely affect the case, and I should therefore like a little enlightenment.

Apparently four 90 kw. 410 revs. per min. and one 47·5 kw. 300 revs. per min. generators existed, and it was decided to couple up to each of these a motor to form independent motor-generator sets, and in addition install two new 63 kw. motor-generators, each of 600 revs. per min.

The necessity, if such there was, for the multiplication of a number of small sets is not apparent from the description of the plant. As is only too well known, small sets are less efficient than large ones, and although possibly the power supply company would not grumble, where the consumer [illegible] the consumer should surely be easy to [illegible] and [illegible] from having a number of small sets [illegible] the [illegible] and maintenance costs.

[illegible]

[illegible]

[illegible]

[We regret that pressure on our space necessitates the holding over of some correspondence.]

As a constant reader of your columns I should like to feel that the article (contributed, I presume) is not altogether valueless.—I am, &c.,

London, Nov. 24. E. W. DOREY.

THE DESIRABILITY OF PROFIT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have just noticed in the editorial of your issue of October 5th the following opening phrase: "In these days, when Socialists talk glibly of capital having no claims to consideration . . ."

I am greatly surprised to find such words in THE ELECTRICIAN, which is generally thought to be rather enlightened. One would not be surprised to find the phrase in other journals, but it comes as a shock to see it in your journal.

No Socialist, no economist who knew anything whatever about economics, would talk so glibly or so foolishly about capital having no claim to consideration. Capital *must* have consideration, and *must* be renewed from time to time. This is *quite elementary* and *fundamental*, and cannot be argued about.

What, then, is the object of the phrase in question? Is it to mislead the ignorant? Is it a slip? Is it camouflage? Anyhow, I trust you will make amends by correcting such a statement, and its effects, as far as possible.—I am, &c.,

London, Nov. 24. F. W. HORROCKS, A.M.I.E.E.

[Our correspondent has surely misread the article. We were advocating the reward of capital. Although the true Socialist would not talk so "glibly," the mass of so-called Socialists do so, apparently knowing nothing of economics.—ED. *E.*]

THE RARER KEY MINERALS.

At the London School of Economics a lecture was delivered on Nov. 16 by Mr. Sydney J. Johnstone, of the Scientific and Research Dept. of the Imperial Institute, on "The Rarer Key Minerals," forming one of a course of public lectures on "The Empire, its Commerce and Commercial Development."

It is well known that the outbreak of war found Great Britain in a somewhat serious position as regards the rarer metals, many sources of which within the British Colonies had fallen under German control. Most of the British chemical and metallurgical firms had but little experience in dealing with such materials as monazite, wolframite, tantalite, &c. Late in 1915 the mining of ores of some of the rarer elements was greatly stimulated by the Imperial Government's scheme for purchasing them at a fixed rate, delivered in the United Kingdom.

Mr. Johnstone gave an interesting summary of the existing sources of these rarer elements within the British Empire, which has at least its fair share of the world's deposits of the rarer key metals.

The tungsten deposits of Burma have the largest output in the world, whilst those of Queensland and New South Wales also make valuable contributions to the world's supply. Tasmania and New Zealand have also a number of undeveloped tungsten deposits. In many other parts of the Empire (South Africa, Federated Malay States) the metal also occurs. The British Empire in 1915 produced [illegible] per cent. of the world's production of this material. In most of the tungsten producing mines in the United Kingdom (*e.g.*, in Cornwall) tungsten is only a by-product, tin being the chief metal extracted.

Probably 90 per cent. of the tungsten ore produced is used in the steel industry as ferro tungsten or tungsten powder. In amounts of 2 to 8 per cent. it confers increased hardness, toughness and tensile strength to steel, rendering it valuable for the construction of armour plate, projectiles, &c. If 15 per cent. is used the resultant steel is self-hardening, and retains its temper and hardness at high temperatures.

As regards its employment in the electrical industry it is stated that the output of pure tungsten within the United Kingdom is now sufficient to meet the demands for glow lamp filaments. Tungsten has also been employed to replace platinum for electric contacts for [illegible] signal relays, &c. Salts of this make are used in the preparation of dyes and colouring materials for cotton, silk and glass, and for fireproofing textile fabrics.

Before the war Germany was the controlling factor in the European market, controlling 30 to 40 per cent. of the world's output. The

erection of plants for smelting tungsten at Widnes and Sheffield, and the extension of similar work at Luton has greatly improved this country's position in this industry.

Mr. Johnstone also gave an account of the monazite sand deposits throughout the world. An important discovery within recent years has been the large deposits in Travancore and Ceylon, which contains as much as 8 to 10 per cent. of thoria, while in the latter country minerals containing as much as 30 per cent. are occasionally found. The deposits in Brazil, on the other hand, contain only half the amount of thoria found in the deposits in Travancore. Apart from the primary use of thoria and ceria for incandescent gas mantles these materials may prove to have other important developments. Cerium has been already used, alloyed with iron, for pyrophoric materials, and more recently a considerable amount of cerium earth salts have been used for the preparation of certain types of electrodes used in flame arc lamps.

Among other valuable key metals occurring within the British Empire are ores of molybdenum and vanadium, both of which are used for treating steel, while tantalum is also to be found in Australia. Zinconium, recently employed for high-speed steels, osmium iridium and other metals likewise in Australasia, while reserves of various key metals exist in the Union of South Africa, Rhodesia and Nigeria. Platinum is one of the few rarer minerals which has not been produced in large quantities in the British Empire, but there are indications that Canada may in the future become an important source of supply.

LEGAL INTELLIGENCE.

Metropolitan Water Board v. Dick, Kerr & Co.

On Monday the House of Lords (the Lord Chancellor, Lords Dunedin, Atkinson and Parmoor) delivered their reserved judgment in this appeal from a decision of the Court of Appeal reversing a judgment of Mr. Justice Bray. The facts of the case were reported in THE ELECTRICIAN for Aug. 4, 1916, and March 9, 1917, and the question at issue was whether a contract for the construction of reservoirs and waterworks at Littleton, made between the appellants (the Metropolitan Water Board) and Messrs. Dick, Kerr & Co., could be treated by the respondents as at an end in consequence of an order of the Ministry of Munitions for the cessation of work under the contract.

The appellants claimed a declaration that the contract by which the respondents had agreed to construct the works for £673,000 was still in existence and that the respondents were bound to perform it.

The respondents contended that by reason of notices received from the Ministry of Munitions the further performance of the contract became impossible and illegal, and that both parties were excused from further performance of the contract and were released from further liability thereunder.

Mr. JUSTICE BRAY held, on the terms of the contract, that the intention of the parties was to enable appellant's engineer to extend the time for performance in every possible event which might delay completion of the contract, including the intervention of the Ministry of Munitions, and that the contract had not in fact been [illegible] or its completion rendered physically impossible or commercially impracticable. The Court of Appeal (Lord Cozens Hardy, Master of the Rolls, Lords Justices Warrington and Scrutton) held that it was an implied term of the contract that the liability to perform it should cease if the Executive, in the lawful exercise of its powers, made performance illegal or impossible, and they gave judgment for the respondents.

[illegible]

It was obvious that the whole character of such a contract for construction might be revolutionised by indefinite delay, such as that which had occurred in the present case, in consequence of the prohibition. The contract in the present case was for the completion and handing over of these works within six years from Aug. 16, 1914. The effect of the prohibition might be that the works could not be resumed until, at all events, the greater part of the six years had expired, and by that time all conditions as regards labour and materials might be absolutely different. That would be not to maintain the original contract, but to substitute a different contract for it.

The other noble and learned Lords gave judgment to the same effect.

A Petition of Right.

In the Court of Appeal (before Lords Justices Pickford and Bankes) on Monday the matter of a petition of right of Marconi's Wireless Telegraph Co. (Ltd.) was heard upon the appeal of the company from an interlocutory order of Mr. Justice Atkin, dated Dec. 7 last year, directing that the petition should be tried before a judge sitting without a jury. The suppliant company contended that the question of fact in the petition should be decided by a jury.

Mr. LESLIE SCOTT, K.C., in support of the appeal, said the subject of the dispute arose out of an agreement made on July 30, 1913, between the suppliants and the Postmaster-General, and the issues involved were considerable. If the agreement was treated as one that would run for 18 years, upon the conservative estimate made on behalf of the company, it resulted in something like £1,500,000 in the way of damages; and if the view was taken that the company was entitled to royalties for 28 years, the damages might be over £2,000,000. Counsel contended that the company had the absolute right to a jury, and that the learned judge had, in refusing to allow the case to go before a jury, exercised his discretion wrongly; and, alternatively, if it was a matter of discretion on the facts of the case, it was plainly a case for a jury. The agreement was for the company to erect six wireless stations in the great wireless chain—England, Egypt, the East African Protectorate, the Union of South Africa, India, Singapore, or some neighbouring part of the Malay Peninsula, and there was a proviso that the Solicitor-General might cancel the contract in respect of three of the stations. The pleadings set out the agreement, and that the suppliants had placed large orders for the contract, and instead of the P.M.G. cancelling the three supernumary stations, he decided that the one in India should be proceeded with. England, Egypt and the East African Protectorate, he suggested, were definite orders. He submitted that by saying India should be proceeded with the P.M.G. had waived his right to repudiate. In preparation for the installation the company did a great deal of work and supplied large quantities of materials. When the P.M.G. repudiated the agreement the company had spent £140,000, of which they received from the Government about £62,000, and the company claimed a declaration, leaving the damages to be arranged or assessed in such way as might be thought fit or expedient. The P.M.G. repudiated the whole agreement in a letter dated Dec. 30, 1914. After the outbreak of the war the suppliants were told not to proceed with the wireless stations. The letter said: "I am directed to inform you the Government have decided not to proceed with the Imperial Wireless Chain." If any question was raised as to what precisely was repudiated, and what the company was not to proceed with, that sentence, said counsel, obviously meant the whole thing.

Lord Justice PICKFORD: May the letter not mean we rely upon that as cancellation of the three, even if we cannot give up the whole six?

Mr. SCOTT contended that that position was untenable. The suppliants had lost the benefit of the whole agreement. [illegible] Jan. 11, 1915, [illegible] the P.M.G. [illegible] efficiency and economy." At the time of the agreement there was no [illegible]

[illegible]

Lord J[illegible]

[illegible]

R. Alger & Sons v. J. Edwards.

At the Glamorgan Assizes recently, plaintiffs, a firm of electrical engineers, sought to recover from defendant the cost of wiring 200 houses in course of erection by defendant for the Great Western Colliery Co.

The dispute arose as to accounts with regard to payments for 37 houses completely wired and 39 houses at which the work had not been completed. These complications were discussed, and the Judge made several suggestions for a mutual agreement, and, eventually, counsel agreed that the Judge should draw up instructions to a referee, who should decide the amounts due to plaintiffs. His lordship intimated that it was desirable that the parties should agree upon a lump sum in settlement.

Damage by Tramway Wires.

In the Court of Passage, Liverpool, recently, Judge Taylor, K.C., gave his reserved judgment in the case of Kent *v.* Liverpool Corporation.

The plaintiff (Mrs. Caroline Kent) claimed damages for personal injuries caused by the fall of the overhead wire of defendant's tramways. Plaintiff suffered from illness and was put to some expense, and damages were claimed for alleged negligence.

In giving judgment, the Judge said that the general management of the overhead line was clearly without fault. The accident happened at what was known as a section insulator. There was a cap or cup, inside of which there was a screw, and the accident would not have happened unless the screw had become unscrewed. For plaintiff, an expert witness had said there was no explanation except that the copper screw had not been tightened, and that, therefore, it had become unscrewed by passing traffic or by vibration. The Corporation expert held that it was wrong to draw that inference, because it was extremely unlikely that their servant would be guilty of such a thing, and that one ought to assume that some accident had happened (a stone thrown by a boy, perhaps) which had produced the unscrewing. It was not an ordinary case, and no accident of the kind had happened before. That was extraordinary when one considered the number of years the tramway system had been working and the quantity of section insulators there were. He concluded the mishap was much less likely to be due to negligence of Corporation workmen than to an accident. He was satisfied that it was not due to negligence and, therefore, he gave judgment for defendants.

Colliery Signalling Patents.

An interesting decision has just been given by the Chief Examiner of Patents. A patent application of the Sterling Telephone and Electric Co. and others, for signal cancelling apparatus No. 105,659, dated May 31, 1916) was opposed by the Automatic Telephone Manufacturing Co. on the grounds of their prior British Patent No. 18,780, of 1914, and unfairness and inadequacy of description.

At the hearing on Nov. 7, Mr. C. Terrell appeared as counsel for he opponents, and Mr. H. W. K. Jennings (Messrs. W. P. Thompson & Co.) as Patent Agent, for applicants.

Mr. Jennings explained the distinctive features and advantages of the Sterling system, and contended that applicant's specification fairly defined the exact scope of their invention.

Mr. Terrell maintained that the applicants' invention was claimed in Claim 5 of the opponents' patent specification.

The Chief Examiner decided that neither of the relays described and claimed by applicants had functions similar to the opponents' first relay; further that applicants' invention did not fall within claim 5 of the opponents, and, finally, that applicants' specification was perfectly fair and gave sufficient notice to the public as to the prior art. Costs were given against the opponents.

Postmaster-General v. Blackpool & Fleetwood Tramroad Co.

At Preston last week Judge Sturges delivered judgment in this action by the Postmaster-General for the recovery of £16. 18s., the cost of alteration and repairs to telegraph wires alleged to have been rendered necessary in order to remedy the injurious effect caused by the leakage of electric current from the tramway lines, which set up corrosion in the lead piping containing the cable at Bispham. His Honour found there was no evidence to the effect that defendants had not complied with the provision in their Act that they should construct and run their undertaking in all respect with due regard to telegraphic lines, and gave judgment for defendants with costs.

Stoker's Neglect of Work.

At Dudley Police Court last week, Frederick [illegible] was summoned by the [illegible], Worcestershire and Staffordshire Electric Power Co. for neglect of work, in respect of which £3 was claimed.

Mr. F. W. [illegible], who prosecuted on behalf of the company, stated that defendant was an assistant stoker at the local power station, but [illegible] negligent in his work, in consequence of which [illegible] had been kept standing. The output of [illegible] had been reduced from 2,400 to 3,000 units per shift [illegible] and the work of the district had been dependent on a [illegible]. Defendant's [illegible] had been [illegible] on [illegible] shift [illegible] claimed in respect of [illegible] per week.

[illegible] had for some time [illegible] per [illegible].

[illegible] it was not [illegible] that [illegible] judgment [illegible] to the end of [illegible].

[illegible] claimed, with [illegible] costs.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents,* 70 *and* 72, *Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1916 Specifications.

12,782 Western Electric Co. & Reinke, A. E. Telephone systems. (9/9/16.) 110,177.

14,521 Sykes Interlocking Signal Co., W. R., & Tarrant, R. W. Electrical commutators. (12/10/16.) 110,193.

14,768 Oldham, G. Separators for electric batteries. (17/10/16.) 110,204.

14,842 Metropolitan Carriage, Wagon & Finance Co., Wilson, W. G., Tritton, W. A. & Morris, D. K. Electrical apparatus controlled from a distance (19/10/16.) 110,207.

15,252 Wolfe, H. L. T. Process or method of uniting similar or dissimilar metals or alloys by electric welding. (26/10/16.) 110,214.

16,749 Wilkinson, R. H. & Turner, W. H. Brakes on electric tramcars and like vehicles. (22/11/16.) 110,231.

16,760 White, A. E. (U.S. Light & Heat Corporation.) Dynamo-electric machines particularly adapted for starting and lighting systems. (22/11/16.) 110,232.

17,072 Soc. Auxiliare des Tramways & Chemins de Fers Soc. Anon. Regulating devices for internal combustion engines coupled with dynamo-electric machines (29/11/15.) 102,501.

17,993 Henkes, C. C. Collection of currents from overhead or other conductors. (12/6/17.) 110,244.

18,049 Railing, M. J. Electric switches. (15/12/16.) 110,245.

18,095 B.T.-H. Co. (G.E. Co.) Electric motor control systems. (16/12/16.) 110,246.

18,193 B.T.-H. Co. (G.E. Co.) Protective devices for electric circuits. (19/12/16) 110,247.

A reverse power relay of the dynamometer type comprising fixed current and potential elements in inductive relation producing a resultant magnetic field, the field of said potential element normally assisting the field of said current element, but under abnormal conditions opposing the field of said current element by a force which is a measure of the potential, and a second potential element producing a magnetic field co-acting with said resulting magnetic field and movable in a direction depending upon the relation of said co-acting field.

18,287 Tubbs, F. R. Apparatus for the electro-deposition of metals. (21/12/16.) 110,248.

1917 Specifications.

1,453 Beith, G. R., & British Agencies, Ltd. Means for locking electric lamps in their sockets. (29/1/17.) 110,462.

2,494 Simms, F. R., & Simms Motor Units, Ltd. Manufacture of armature driving spindles for magneto-electric machines. (20/2/17.)

3,125 Garin, M. V. Apparatus for the electrolytic production of copper and other metals. (2/3/17.) 110,474.

4,237 Philips-Brinton Co. Electrical condensers and process of making same (23/3/16.) 105,33.

4,860 Saxelby, F. A., Bluemel, F. H. & Bluemel Bros. Sparking plug. (4/4/17.) 110,492.

4,865 Lucas, H. & Edwards, W. H. Plug connexions for electric circuits. (4/4/17.) 110,493.

5,267 Le Pontois, L. J. Ignition dynamo-electric generators. (13/4/17.) 110,496.

7,004 Cable Accessories Co. & Reeves, F. H. Electric lamp holders. (16/5/17.) 110,509.

7,150 Hall, S. Wireless telegraph aerials. (18/5/17.) 110,513.

9,801 Berry, W. H., & Markham, W. J. Electric switches. (6/7/17.) 110,523.

11,867 Naamlooze Vennootschap de Nederlandsche Thermo-Telephoon Maatschappij. Heating conductors of thermic telephones. (15/9/16.) 109,797.

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

October 27, 1917.

15,670 Eastern Telegraph Co., Judd & Davies. Electrical regulating apparatus.

15,688 Smith & Sons, Dorer & Rogers. Electrical switches for motor cars, &c.

October 29, 1917.

15,722 Fawcett & Hoyle. Holders or fittings for electrodes of electric furnaces.

15,736 A. G. Brown, Boveri et Cie. High tension distributors for ignition in multi-cylinder internal combustion engines. (6/11/16, Germany.)

15,741 Comp. Phoebus. Electric rocket lamp. (28/10/16, Switzerland).

15,745 Bloxam. (Stabilimenti Biak Ing. A. Rouchain.) Electric furnaces.

October 30, 1917.

15,774 Angold & Railing. Electric arc lamps.

15,777 Willcocks. Electric switches.

15,779 Avery. Locking device for electric lamps.

15,810 Murray. Telephone systems.

15,815 Chloride Electrical Storage Co. & Dean. Accumulators.

15,821 Beaver & Claremont. Teastsheath joint for electric cables.

15,837 Berry. Electrical transformers.

15,844 Soc. Francaise Radio-Electrique. Radio telegraphy or telephony.

15,846 Soc. Francaise Radio-Electrique. High-frequency alternator.

VOLUNTEER NOTICES.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Oxford-street, W. 1.

Orders for the Week.

Officer Commanding, Lieut.-Colonel C. B. Clay, V.D.

Officer for the Week.—Second-Lieut. H. G. Golding.

Next for Duty. Second Lieut. P. Bowden.

Extract from "London Gazette." F. Gaywood to be temporary Second-Lieut. (Oct. 24); H. J. Golding to be temporary Second-Lieut. (Oct. 24).

Drills: Week ending Saturday, Dec. 8, 1917.

Monday.—No. 3 Company, Left Half, Recruits, Signalling, 6.30.

Tuesday.—Physical Drill and Bayonet Training, 7.30.

Wednesday.—No. 1 Company, 6.30.

Thursday.—No. 2 Company, 6.0. Signalling, Ambulance, 6.30.

Friday.—No. 3 Company, Right Half, Recruits, 6.30.

Musketry.—Belvedere-road, Tuesday, Wednesday and Thursday, 6.30 to 7.0.

Note.—The Medical Officer will attend for examination of recruits [illegible] on Thursday at 6.30.

Unless otherwise indicated, all drills will take place at headquarters.

COMMERCIAL & INDUSTRIAL SECTION.

Controlled Firms and Advertising.

A suggestion made by the Ministry of Munitions to Government controlled firms that they should limit their expenditure on advertising to one-fifth of the pre-war standard has aroused considerable opposition in engineering circles.

It appears that the Ministry maintain that "advertising expenditure for after-the-war purposes is a charge to be met out of profits, and is not part of the manufacturing cost." The "Evening Standard" very pertinently points out that every business man knows that advertising is treated as a first cost by every commercial concern, and Government controlled firms must, of course, keep alive their goodwill during the period of Government control, especially as the control carries with it a disorganisation of the normal trade of the firm. The only alternative would seem to be that firms should be allowed to write off a heavy proportion of the sum assigned to goodwill. It is to be hoped that before the Ministry take any definite action in the matter the views of manufacturing firms and exporters will be fully weighed. The building up of a trade connection is a long and difficult task, and the work of years can be readily lost unless firms keep their goods constantly before the buying public.

* * * *

Financial Facilities for Traders After the War.

The Treasury and the Minister of Reconstruction have appointed a Financial Facilities Committee :—

To consider and report whether the normal arrangements for the provision of financial facilities for trade by means of existing banking and other financial institutions will be adequate to meet the needs of British industry during the period immediately following the termination of the war, and, if not, by what emergency arrangement they should be supplemented, regard being had in particular to the special assistance which may be necessary :

(*a*) To facilitate the conversion of works and factories now engaged upon war work to normal production.

(*b*) To meet the exceptional demands for raw materials arising from the depletion of stocks.

The committee consists of the following: Sir Richard V. Vassar-Smith, Sir John Bradbury, Mr. A. E. [illegible], Mr. E. Brocklehurst Fielden, Sir Algernon Firth, Mr. Robert [illegible], Mr. A. C. D. Gairdner, Mr. Frederick C. Goodenough, Sir Alex. McDowell, K.B.E., Sir Alex. Roger, Mr. John Sampson, and Mr. A. W. [illegible]

* * * *

National Council for the Clay Industry.

The clay industries appear to have been the first to create an employers' national council.

At a meeting last week, Mr. J. H. WHITLEY, M.P., said the aim was to re-create in each industry something of the good there was in the old guild system, when every workman had pride in his work and his industry as a whole.

Mr. Whitley also said that what was proposed was a controlling and directing organisation. There was, apparently, no intention of pooling capital and profits or of controlling prices. There was a possibility of such organisations becoming a monopoly, and the State was bound to take cognisance of anything which would tend to a monopoly. The proposal to introduce the buying of raw material for the industry and for export on co-operative lines would receive encouragement by the Board of Trade.

* * * *

Control of Trade.

Considerable opposition has been aroused in commercial and industrial circles to the Government Bill for the continuation of the control of imports and exports for three years after the termination of the war.

Several Chambers of Commerce have already passed resolutions of protest, and at the [illegible] on Monday the following resolution was [illegible]: "That this meeting of merchants [illegible] connected with [illegible] strongly opposed to the [illegible] after the war [illegible] that the best interests of the [illegible] the least possible delay."

* * * *

China's Commercial Possibilities.

Mr. M. A. Oudin, [illegible] of the foreign department of the General Electric Co. of America, [illegible] recently made a trip to [illegible] and China on behalf of his company, delivered an address [illegible] before the American Manufacturers' Export Association.

[illegible] the United States [illegible] would result in [illegible] legitimate activity of the American manufacturer, merchant and banker. China was now [illegible] their enterprises and a sphere for a strong economic development. Leaving out of calculation all the foreign settlements in China, the marks of progress were very remarkable.

The Powers would do their part by China and conform to the new world conditions, Mr. Oudin said. Were they to refrain from secret opposition to the commercial activities of one another, and renounce all pretensions, the exploitation [illegible] interests and honour of that country? If not now, these things were likely to come to pass at the end of the war, when the struggle against ruthless militarism, universal dominion and economic imperialism was won and Governments were [illegible] justice. At the peace conference the weak and undeveloped countries would demand restitution and the protection of their right to independence and the free development of their national life. If the entrance of the United States into the war meant anything, if the recent utterances of the allied nations as to their aims meant anything, if the Russian revolution had any significance, the case of the weak and undeveloped countries would receive a fair and just hearing. The war is China's opportunity.

* * * *

German Industrial Organisation.

The "Board of Trade Journal" gives particulars of the progress of the syndication and concentration of German industries.

The German Pig-Iron Union, which was due to expire at the end of 1920, was reconstituted at the end of July last. The Steel Works Union was due to expire on July 30 last, and the question of its renewal was expected to give rise to serious difficulties.

In the iron and steel industries, the tendency to establish big mixed concerns, to combine coal mines with smelting and steel works, and steel works with rolling mills, has again become prominent.

It was reported in June that [illegible] in the tool industry. These associations have formed a conjoint organisation, under the title of "Werkzeug-und Stahlkontor G.m.b.H.," in Remscheid, which looks after the purchase and distribution of raw materials, especially steel.

It was reported in the German Press about the middle of July that a request, supported by [illegible] fine iron plate works to consider the question of a combine.

A Bundesrat Order [illegible] compulsorily to combine owners of graphite mines and graphite preparing establishments [illegible] istration of their graphite mines and works, the supply of their works with electric power, and the regulation of their sales, &c.

Instances of combinations in the mining, motor vehicle, and other industries are also given.

* *

Scientific Research in South Africa.

The report for 1916-17 of the South African [illegible] referring to the work of the [illegible] Board and of the [illegible] of the Department of Mines and Industries [illegible] is to investigate the raw products and [illegible] of the country, and to advise the Minister of Mines and Industries on industrial matters [illegible]. The Committee was appointed on the suggestion of the [illegible].

[illegible]

ELECTRICITY SUPPLY.

EXTENSIONS.

Greenock.—The Secretary for Scotland has sanctioned the borrowing of an additional sum of £53,000 for extensions of the electricity undertaking. This sum will make the total amount borrowed for the undertaking £465,000.

Hackney (London).—Application is to be made to the L.C.C. for sanction to borrow £28,000 for an extension of the steam-raising plant at the generating station.

The estimated cost of plant capable of raising 66,000 lb. of steam per hour is put as follows: Two boilers, £12,150; two economisers, £2,250; two sets flues, fans, motors and chimneys, £4,080; two brickwork settings, £2,250 (one pump pit provisional), £290; lagging galleries, £750; insurance company's inspection (provsional), £75; travelling hopper, £495; cutting away roof (provisional), £150; two feed pumps, £985; pipework lagging, &c., £2,450; contingencies, awards to labour, &c., £1,575. Total, £27,500.

The borough electrical engineer (Mr. L. L. Robinson) has been instructed to obtain an estimate from Messrs Babcock & Wilcox for the plant required.

Swansea.—Application is to be made to the L.G. Board and any other necessary authorities for sanction to borrow £39,000 for the installation of plant consequent upon the taking over of the supply of electricity to the Harbour Trust, and large independent consumers in the borough. The engineer (Mr. J. W. Burr) has been instructed to obtain tenders for the plant required.

The Council has taken over the supply of electricity to the Harbour Trust on the following conditions:—The supply to be given as from a date to be agreed upon, but in any case not later than June 30, 1918, subject to the Corporation being in a position to supply on that date; the Corporation will supply energy up to 500 k.v.a. and to make arrangements to supply with all reasonable speed up to 1,000 k.v.a.; the price to be paid by the Trustees to be £2 per kilowatt per annum, plus 0·585d. per unit, subject to the fluctuations in the price of coal; the Trustees to pay a minimum of £2,000 a year from the commencement of the supply, provided that until the Corporation are in a position to supply up to 1,000 k.v.a. the minimum sum shall be £1,500 a year. The agreement to be for seven years from the commencement of the supply, with the option to the Trustees of continuing the same for a further seven years.

Willesden.—Application is to be made to the L.G. Board for permission to raise a sum of £2,900 for cable extension.

An offer has been received to purchase land belonging to the Council at Denzil-road, originally acquired as a site for a generating station. If the land be disposed of if will be necessary to extend a h.t. cable to a factory to be erected, and to provide a transformer at an estimated cost of £900. Application is also to be made to the Board to sanction the borrowing of this amount.

GENERAL.

Belfast.—The Committee on Production has issued its award on the question at issue between the Electrical Trades' Union and the Corporation with regard to the employment of certain electricians on overhead line maintenance.

The award is in favour of the Corporation, but as the men concerned had reasonable ground for claiming that the termination of their contract of service should be suspended until the dispute had been settled by arbitration, the Committee thinks that the Corporation should pay the wages of the men at the rate in operation on Aug. 23 to Nov. 17, the date of the award.

Board of Trade Electric Power Supply Committee.—On Monday the Lord Provost of Glasgow (Mr. J. W. Stewart), and the general manager and engineer of the Corporation electricity department (Mr. William W. Lackie), gave evidence before the Board of Trade Committee on Electric Power Supply.

Last week the Council agreed that if the country is to be divided into areas for generating electricity, the Corporation are willing, on satisfactory terms, to provide for the Glasgow and Clyde district. Lord Provost Stewart and Mr. Lackie gave evidence in support of that resolution, the former dealing with the general question and Mr. Lackie specially with the financial and technical aspect.

At the [illegible] of the Convention of Royal Burghs last week, Councillor Stevenson, of Edinburgh, reported that in giving his evidence before the Committee, he (Councillor Stevenson) said there would be a marked difference of opinion when it was sought to unite private and municipal enterprises, or alternatively to eliminate one at the expense of the other. He stated his strong preference for municipal control on the ground that electricity was gradually becoming more and more a public necessity, and it was not in the public interest that it should be in the hands of private companies, even if they were limited to a certain rate of dividend. A combination of all companies and local authorities in each industrial district was quite impracticable, while any attempt to put all the electricity undertakings under a power company would create such local opposition that success along these lines could not be attained.

The Chairman (Provost Keith, of Hamilton) said he did not think any one of them would like to see the electrical power of either the country or of separate communities placed in the hands of any large company.

Bristol.—Ald. G. Pearson has been re-elected chairman of the Electricity Committee for the ensuing year. Mr. A. E. Thomas is vice-chairman in place of thr late Ald. S. Lloyd, and Messrs. Stock & Perrett have been elected new members of the committee.

Gainsborough.—Mr. James Marshall, of Messrs. Marshall, Sons & Co., has decided to apply for a provisional electric lighting order for the supply of electric energy for all purposes in Gainsborough.

Messrs. Marshall are erecting a large power station on a site on the Trent, and they will be in a position to give a supply of electricity from this station when completed. The Council obtained a provisional order some years ago, but nothing has been done to carry out its provisions.

Lowestoft.—The salaries of the borough electrical engineer (Mr. W. R. May) and the general manager of the tramways (Mr. H. H. Saunders) has been increased to £355 per annum each.

St. Pancras (London).—The Electricity Committee has appointed Councillor C. F. Parsons as chairman and Councillor W. G. Grey as deputy-chairman for the ensuing year.

The 2,000 kw. turbine set at King's-road station recently broke down. This machine had been running continuously for nearly three years, but owing to existing conditions it had been found impossible to overhaul it during that time. The spare parts are in hand for replacement, but owing to scarcity of labour three weeks will be required for effecting the necessary repairs. In the meantime, through the courtesy of the L.C.C., arrangements have been made to obtain assistance from their Tower station. Large consumers had reduced their demands during the maximum load period, thus relieving the undertaking in the serious position in which it was placed. It is proposed that the connection with the L.C.C. sub-stations should so far as practicable be made permanent so as to be of mutual assistance should occasion arise.

Wages of Electricity Works Employees.—In a circular letter issue by the Town Clerk of Hammersmith it is pointed out that questions as to rates of wages paid to different grades engaged in the Council's electricity undertaking have been brought before Committees of this Council, sometimes upon an application of the men concerned, and at other times upon a representation by one or other of the Unions claiming to represent the different sections of men.

There have been difficulties in dealing with such applications owing to the uncertainty of the effect which any action which they may take might have upon the position of other generating stations. It is therefore suggested that a Federation of electrical supply authorities should be formed in London and Greater London, whose particular function it would be to consider, from a federation point of view, the rates of salary and wages paid to persons engaged in the generation and distribution of electricity. Other Councils are asked if they are prepared to assent to the suggestion, or if they think the matter is one which should be discussed at a meeting of representatives of electricity undertakings.

We understand that the Wages Conference of Local Authorities owning electricity undertakings in Greater London recommends the adoption of the award of 15s. increase upon the pre-war wage to all employees affected by the award of the Committee on Production and to the technical staff, to date from September 1st, such 15s. to be inclusive of any increase granted since August, 1914, as war bonus or war wages.

Wages of L.C.C. Employees.—The electrical mechanics and electrical labourers on the permanent staff of the Chief Engineer's department of the L.C.C. are to receive 12s. per week above their usual pay as war wages.

ELECTRIC TRACTION.

Board of Trade Tramway Control Committee.—Croydon Tramways Committee recently considered the Committee appointed by the Board of Trade to control the supply of materials and labour for tramway undertakings essential to the prosecution of the war, and passed the following resolution:

The Committee concur in the proposal to set up the Expert Committee, but regret that municipalities are inadequately represented thereon, and are of opinion that such representation should be increased. The Committee, therefore, recommend that the Board of Trade be informed accordingly.

The Council is further of opinion that the terms of reference should also include consideration of the Control of Motor Omnibuses.

On Tuesday the London County Council authorised Mr. A. L. C. Fell, the manager of the tramways undertaking, to serve on the above committee.

Light Railways.—Swansea Corporation has applied to the Light Railway Commissioners for an Order reviving and extending for two years the powers granted by the Swansea Corporation Light Railways (Extensions) Order, 1914, for the purchase of lands.

Manchester.—Recently the Tramways Committee refused an application of the tramway workers to give no tramway service on Christmas Day, but now the workers have decided not to work on that day.

Pontypridd.—The Electricity and Tramways Committee has applied to the Board of Trade for sanction to increase workmen's fares from ½d. to a 1d.

MISCELLANEOUS.

British Homestead Association.—We are asked to call attention to an appeal for funds for this association.

The appeal explains that the object of the association is to provide homes for discharged officers and men of H.M. Services, and opportunities of exercise on the land, and it is suggested that these objects are worthy of support by other engineering firms. From the war fund of Thos. Firth & Sons' employés a contribution of £25 has been made to the association.

County of London War Bulletin.—We have received a copy of the fifth edition of the staff war Bulletin of the County of London Electric Supply Co. and its associated companies. The present issue brings up to date the information relating to the members of the staffs and employés on active service.

The total number of names in the Roll of Honour is now 467. The total killed is 32, and 62 have been wounded. Commissions are now held by 26 members of the staffs. Capt. C. Bollam, R.N.B. (of the Bournemouth Co.), Second-Lieut. H. F. Gill and Lieut. N. F. Hawes (County of London Co.) have been awarded the Military Cross, and Corporal C. Coles (Bournemouth Co.) has obtained the Military Medal, and Second-Lieut. H. A. Moncrieff (County of London Co.) has gained his double wings as a lieutenant in the Royal Flying Corps.

Inquest.—On the 21st inst. an inquest was held upon Murdoch McLean, who met his death at the Silverwood Colliery Coke Ovens on the 19th inst.

Deceased was in charge of a slack compressor electrically driven. A fellow workman saw him fast on a live trolley wire, along which passed electric current of 550 volts. The machinery was stopped, but by this time the compressor had knocked McLean off, and gone over him. The supposition was that he got on the cake-box side in order to close a slide, slipped, and in trying to save himself grasped the wire. It was against the rule to get on the box when the machine was in motion.

The jury returned a verdict of "Accidental death," and suggested the posting of a warning notice.

Telegraph Cable Lodge.—The installation meeting of this Lodge took place at the Criterion Restaurant (London, W.) on the 14th inst., when the outgoing master, Bro. W. W. Howell, installed Bro. T. A. Davies in the chair.

Among the officers appointed by the new W. M. were Bros. W. Lloyd, S.W., J. H. Stephens, J.W., H. St. L. Smith, L.R. Secretary, F. O. Thompson, L.R., D.C., Stanley Brown, S.D., C. Rodgers, J.D., and Capt. J. C. Denison-Pender, M.P., I.G.W. Bro. T. A. Bullock, P.M. P.G.S.B., retains the office of Treasurer which he has held since the consecration of the Lodge in 1893.

TENDERS INVITED.

Electric Wire and Cable and Electric Bell Fittings.

The COMMISSIONERS OF H.M. WORKS, ETC., invite tenders for supply of electric wire and cable (for one year from Jan. 1, 1918), and for electric bell fittings during period ending March 31, 1918. Forms of tender, conditions of contract, &c., may be obtained from the Controller of Supplies, King Charles-street, Westminster, S.W.1, and tenders must be delivered by 11 a.m. Dec. 6 to the Secretary, H.M. Office of Works, Storey's gate, London, S.W.1. *See our advertisement.*

Telegraph and Telephone Instruments, Battery Material, &c.

Tenders are invited up to Dec. 5 and 12, 1917, respectively, for the supply to the Postmaster-General's Department, State of WESTERN AUSTRALIA, of telegraph and telephone instruments and battery material (to schedule W.A. 583) and telephone switchboards (to schedule W.A. 582). Tender forms, specifications, &c., from the office of the High Commissioner for Australia, Australia House, Strand, W.C. 2. *See advertisement.*

Turbo-Alternator and Condensing Plant.

CARDIFF Corporation require tenders by 9 o'clock Dec. 4 for supply and erection of a 1,500-2,000 k.w. high-pressure Turbo-Alternator and Surface Condensing Plant for same. Specification, &c., from the City Electrical Engineer.

Cooling Towers.

MANCHESTER Electricity Committee require tenders by 10 a.m., Dec. 12, for the supply and erection of three fan-draught cooling towers at Stuart-street electricity works. Specifications, &c., from Mr. F. E. Hughes, Town Hall, Manchester.

[illegible].—The Council has accepted the tender of Crompton & Co. [illegible] for a motor generator and switchgear for charging the batteries of electric vehicles.

Government Contracts.—The following tenders were accepted by the British Government Departments during October:—

War Office.—India Rubber, Gutta Percha & Telegraph Works Co., Chatterton's compound; Lancashire Dynamo & Motor Co., dynamos, switchboards, &c.; Austin Motor Co. (1914), Coventry Simplex Engines (Ltd.), Electric Construction Co., R. A. Lister & Co., and Phœnix Dynamo Mfg. Co., generating sets and spares; Bullers (Ltd.) & F. W. Cotterill (Ltd.), field insulators; E. Brook (Ltd.), Crypto Electrical Co., Syer & Co., and F. Parkinson & Co., motors, &c.; Benjamin Electric (Ltd.), and Veritys (Ltd.), iron shades. Stevens Petrol Electric Vehicles (Ltd.), petrol-electric vehicles.

India Office.—Chloride Electrical Storage Co., accumulator plates; General Electric Co., cells; Siemens Bros. & Co., fittings for telephone parts.

H.M. Office of Works.—Crompton & Co., electric generating plant for Barry Dock grain stores and motors and starters for Ordnance Service Office; Harland Engineering Co., electric supply at Cardiff grain stores; British Insulated & Helsby Cables, flexible cables for grain stores; Lund Bros. & Co., electric wiring at King's Dock, Swansea. General Electric Co., key switch holders.

Post Office.—British L. M. Ericsson Mfg. Co., protective apparatus; Automatic Telephone Mfg. Co. and India Rubber, Gutta Percha & Telegraph Works Co., telegraph apparatus; British L. M. Ericsson Mfg. Co., Peel-Conner Telephone Works Co. and Western Electric Co., telephone apparatus; Bullers (Ltd.), bodies and covers for insulators; Telegraph Construction & Maintenance Co., [illegible] British Insulated & Helsby Cables, Callender's Cable & Construction Co., Connolly Bros., W. T. Glover & Co., W.T. Henley's Telegraph Works Co., Johnson & Phillips and Union Cable Co., telegraph cable; London Electric Wire Co. & Smiths and Western Electric Co., telephone cords; Automatic Telephone Mfg. Co., British L. M. Ericsson Mfg. Co., Western Electric Co., telephone plugs; Bullers (Ltd.), telegraph poles; Bayliss, Jones & Bayliss, insulator spindles; Bullers (Ltd.), pole steps; D. Gilson & Co., telephone terminals; T. Bolton & Sons, British Insulated & Helsby Cables, and F. Smith & Co. (Inc. in London Electric Wire Co. & Smith's), bronze wire; R. Johnson & Nephew, Rylands Bros., Shropshire Iron Co., F. Smith & Co., and Whitecross Co., g.i. wire.

APPOINTMENTS VACANT AND FILLED.

A head clerk is wanted for large marine engineering establishment. *See advertisement.*

Oldham Corporation Electricity Committee require a shift engineer. Wages £2 10s. a week with 12s. war bonus. Applications to Mr. Fred. L. Ogden, joint electrical engineer and manager, Greenhill Electricity Offices, Oldham, by Tuesday, Dec. 4.

The Education Committee of the Borough of Swindon invite applications for the permanent appointment of head of the engineering department of the Technical Institute. Commencing salary £250 a year. Applications to the Principal, Mr. G. H. Burkhardt, M.Sc., by Dec. 8. *See an advertisement.*

The National Boiler and Engine Insurance Co., St. Mary's Parsonage, Manchester, advertise for additional electrical inspectors. Applications to the engineer.

A charge engineer is required for a London controlled establishment. *See advertisement.*

An assistant engineering master is required for day and evening lasses at the Lincoln Municipal Technical School. Commencing salary £180 to £200. Forms of application from the Principal, to whom applications by Dec. 8.

A teacher of electricity is required for the Merchant Venturers' Technical College, Bristol. Commencing salary £230, rising to £250 per annum. Forms of application from the Registrar. *See advertisement.*

An assistant is wanted for the technical department of an electric control gear works.

Applications are invited for the position of Principal of the Coventry Municipal Technical School. Commencing salary £600. Particulars from the secretary (Mr. Frederick Horner), Education Department, Council House, Coventry. Applications by Dec. 1.

Mr. W. Cranfurd and Mr. F. T. Holt, assistants in the Tramways department of the L.C.C., have been appointed assistant permanent way engineers at a commencing salary of £325, rising by annual increments of £25 to £400 a year.

Mr. Geo. H. Lofts has been appointed [illegible] of the [illegible] branch of the Government hydro-electric undertaking.

BUSINESS ITEMS.

We are asked to state that the [illegible] Co. referred to [illegible] London and Liverpool [illegible] 675, Commercial-road, London, E. 14, who are the owners of the [illegible] Limited.

[illegible]

Engineering Amalgamations.—[illegible] have purchased the undertaking of [illegible] of Middlesbrough.

Messrs. [illegible] have also acquired the [illegible] Messrs. [illegible] Dewar & Co., of Glasgow.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

Western Telegraph Co. (Ltd.)

The 84th ordinary general meeting was held on Nov. 21 under the presidency of Sir JOHN WOLFE BARRY, K.C.B., the chairman of the Company.

The SECRETARY (Mr. E. STEER HODSON) having read the notice calling the meeting and the auditors' report,

The CHAIRMAN said: Gentlemen, the revenue for the year ended June 30 last shows an increase of roundly £91,000, of which £66,000 was from message receipts, and £25,000 from interest on investments. Working expenses increased by £46,000 odd and income tax and excess profits duty by nearly £11,000. This last item, however, we are fortunate in being able to balance by a decrease of an almost similar amount in the cost of the maintenance of our cables. After providing £32,747 for debenture stock interest and £149,225 for income tax and excess profits duty, the balance is £493,432. With £38,344 brought forward the total of £531,776 is within £3,000 of the total for 1915–16. The directors have transferred £150,000 in further reduction of the amount of capital expenditure in excess of the share capital and debenture stock issued, £100,000 to the general reserve fund, £30,000 to the land and building depreciation fund, and £50,000 to the maintenance ships reserve fund. Three interim dividends of $1\frac{1}{2}$ per cent. each and a final dividend of $1\frac{1}{2}$ per cent., also a bonus of 2 per cent. have been paid, amounting together to £166,344, making a total distribution of 8 per cent., free of income-tax, for the year ended June 30, 1917, thus leaving a balance of £35,432 to be carried forward.

Since the beginning of April last the Company has inaugurated a direct telegraph line connecting the important city of San Paulo with our station at Santos. The line is operated by the Company's staff, who in San Paulo are accommodated in the Brazilian State telegraph office. The results have so far been satisfactory. At one of our annual meetings the shareholders were informed that negotiations were proceeding with a view to our laying a direct submarine telegraph cable from Rio de Janeiro to the Island of Ascension. I am glad to say that the President of Brazil has recently signed a decree authorising the Company to carry out this undertaking, and also to lay a cable from North Brazil to the Island of Barbados. The details of the necessary contract with the Brazilian Government are now being discussed with the authorities. By these new cables the public in Brazil and other countries will obtain increased telegraph facilities. In the year 1897 this Company guaranteed the principal and interest of £150,000 four per cent. debentures of the West Coast of America Telegraph Co. and received from that company as consideration 15,000 of its fully paid shares of the nominal value of £2 10s. each. The debentures were redeemed on the due date, namely, [illegible] 1 last, and our Company had to provide £100,000 towards the redemption. In exchange we have received that amount in 6 per cent. preference shares of the West Coast Co. The Western Co. also made an offer to purchase ordinary shares from the other proprietors of the West Coast Co., with the result that a large number availed themselves of the opportunity, and your Company now hold about 93 per cent. of the ordinary capital.

He concluded by moving the adoption of the report and accounts for the year ended June 30.

The DEPUTY CHAIRMAN (Sir John Denison Pender, K.C.M.G.) seconded the resolution, which was carried unanimously.

On the motion of the DEPUTY CHAIRMAN, seconded by Sir ALBERT J. LEPPOC CAPPEL, K.C.I.E., the retiring directors, Sir John Wolfe Barry, K.C.B., the Right Hon. Lord Balfour of Burleigh, K.T., G.C.M.G., G.C.V.O., and the Right Hon. Viscount Midleton, K.P., were unanimously re-elected. Messrs. Deloitte, Plender, Griffiths & Co. and Messrs. Cooper, Jackson, Jefferys & Freeman were also re-elected auditors, and a vote of thanks to the chairman and directors terminated the proceedings.

AUCKLAND ELECTRIC TRAMWAYS CO. (LTD.)—Mr. C. G. Tegetmeier, who presided over the annual meeting last week, said there was a substantial increase in receipts, but an almost equal increase in working expenses. The year's receipts were £282,697, an increase of [illegible]. The number of passengers carried was 13,351,000 or nearly 1,000,000 more than in the preceding year. It was a cause for congratulation that [illegible] [illegible]

In the current year their expenses would certainly be largely increased; they would have to meet much heavier taxation, while the present increased scale of pay to their men was operative for only a portion of last year, and the upward tendency in the cost of all materials would undoubtedly continue. Their traffic receipts showed some improvement over last year, and they could only hope that the improvement would be maintained to an extent which would enable them to meet the increased expenses without a material reduction in their profits.

BOGOTA TELEPHONE CO. (LTD.)—The directors' report for year ended June 30 states that the demands for telephone service continued. The Company has been fortunate in being able to proceed with the installation of the new extensions, in spite of the difficulty they are experiencing in the exportation of the new plant and apparatus required. The equipment at Bogota has been maintained in an efficient condition and the service rendered continues to give satisfaction.

CASTNER-KELLNER ALKALI CO. (LTD.)—The directors' report states that the net profit, after allowing for amount expended in maintaining the works, plant and machinery, and after making provision for excess profits duty, was £263,321, with amount brought forward (£39,404), the available total is £302,725. Deducting debenture interest (£7,647) and the interim dividend (£90,000), the available balance is £205,078. The directors recommend the appropriation of £50,000 to depreciation reserve, £110,000 for payment of a final dividend of £11 per cent., making (with the interim dividend) £20 per cent. for the year, leaving £45,078 to be carried forward, a portion of which will be required for further excess profits duty in respect of year to Sept. 30, 1916.

ELECTRICAL SECURITIES TRUST (LTD.)—The report for the year ended 14th inst. states that, after charging all expenses, there is a loss of £629. No credit has been taken for interests or dividends which may have accrued and which have not been paid. The directors regret that they have been unable to dispose of any of their investments.

NEW COMPANIES.

G. & S. (LTD.) (148,816).—Private company. Reg. Nov. 5, capital £1,200 in £1 shares, electrical, general and mechanical engineers, machinists, &c. Agreement with K. E. L. Guiness and C. M. Smith.

T. PRICE & SONS (STAMPERS) LTD.) (148,868.)—Private company, Reg. Nov. 10. Capital £10,000, in £1 shares, to take over the business of stampers, piercers, metal spinners, &c., carried on by the executors of the late T. E. Price, as T. Price & Son, also to carry on the business of manufacturers of electricity and gas fittings, &c. First directors are Mrs. F. M. Price, T. B. Scattergood, A. Round and W. E. Bingley. Reg. office, Spring hill-passage, Springhill, Birmingham.

SCRIVEN & CO. (LTD.) (148,918.) Private company. Reg. Nov. 17, capital £20,000 in £1 shares (10,000 preference), to take over the business carried on by Scriven & Co. at Leeds, and to carry on the business of engineers, machine tool makers, iron, steel and brass founders, electrical engineers, &c. First directors are: J. W. Crosthwaite, G. D. Crosthwaite, J. Clark, J. Tearle, H. A. Thornton, A. E. Inceson and J. Scriven.

STAVELEY ELECTRIC SUPPLY CO. (LTD.) 148,901.)—Private company. Reg. Nov. 16, capital £5,000 in £1 shares, to carry on at Staveley and elsewhere in Derbyshire the business of an electric lighting and supply company. First directors are: C. P. Markham, J. Court and C. W. Kendall.

W. & D. CONVEYOR ENGINEERING CO. (LTD.) (148,893.)—Private company. Reg. Nov. 14. Capital £10,000 in £1 shares. Manufacturers and dealers in labour-saving machinery in connection with the transport of goods, runways of all kinds, elevating machinery, stackers and conveyors, electrical engineers, &c. First directors are H. C. King, T. Fletcher, W. H. Weguelin, W. E. P. Doudney and C. H. Bennett.

CITY NOTES.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—The units sold to consumers during the four weeks ended Sept. 28 amounted to 2,354,138, compared with 2,156,682 units in the corresponding four weeks of 1916.

CALLENDER'S SHARE & INVESTMENT CO. (LTD.)—A dividend of $2\frac{1}{2}$ per cent. (less tax) has been declared for the past half year, making 5 per cent. for the year. A sum of £500 has been placed to reserve, £711 written off preliminary expenses and £5,279 carried forward.

BRITISH ELECTRIC TRACTION CO. (LTD.)—The directors have declared the dividend of 5 per cent. on the accumulative participating preference stock for the half year ended Sept. 30.

NORTHAMPTON ELECTRIC LIGHT & POWER CO. (LTD.)—Subscriptions are invited for 14,000 B shares of £1 each at par, being the balance of the 30,000 shares offered in January last.

POWER GAS CORPN. (LTD.)—The directors recommend a dividend at rate of 6 per cent. per annum (less tax) on the ordinary shares.

RICHARD HORNSBY & SONS (LTD.)—The directors recommend a dividend of $6\frac{1}{4}$ per cent. on the ordinary shares for the year ended Sept. 30, compared with 10 per cent. for 1915–16.

RUSTON, PROCTOR & CO. (LTD.)—A dividend of 5 per cent. has been declared on the ordinary shares.

THE ROUND TABLE.

By "KVA."

SPARKS FROM AN ELECTRICAL PHILOSOPHY.

Don't reciprocate; leave that to pistons, connecting rods and bell crank levers, it's their business.

Be just plain R.P.M., like the electric motor, and go through life with ring oiled bearings. You'll ensure perfect lubrication and great economy of oil.

* * * *

Barry Pain in the "Daily Chronicle" says the verb, to be matchless—that is, to be without matches—is grossly irregular, and is at present conjugated as follows:—

I am matchless.
Thou hast a patent lighter that won't work.
He—dirty dog—has four that he sneaked from the club.
We use spills when we have anything to light them from.
You can't light a cigarette from an electric torch.
They write to the papers.
We use electric light.

* * * *

That it is an Engineer's War is confirmed by the recent adaptation of Nelson's motto, "England Expects that every Tank this day will do its damnedest"!

* * * *

Incidentally I hear that the difference between the male and female tank is that the latter carries smaller guns than its mate. Whether they strafe the Hun in pairs is not yet officially disclosed.

* * * *

A Round Table reader sends me another specimen of the kind of letter which manufacturers receive at odd intervals from the Far East:—

"Dear Sirs: We beg to acknowledge your favour of the Oct. 25th. and we thank you therefor very much. We have the honour to send you herewith a list of all our Reference's. The Reference's from England, are of men for whose we have what have done, any time' past. Some of them, we do n't know or they life's where momently, but we will give you all the adresses from which we think that they can tell you some thing of us.

"When you find that the reference's are satisfactory enough, then we will be very glad, when you will send uslso many catalogues and particulars which you think to give.

"We will be very glad, when the matter will go very good than. But we think that the time past War, will were the best. When we than are ready with you, we think to can make, the best business.

"Yours very truly."

What one might call the language of eddy currents!

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN, November 27, 1880.]

THE ELECTRIC LIGHT IN THE CITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The publication of the results of tenders for electric lighting in the city, together with the delay in publishing the official record of the Glasgow trials, has compelled me to request you to give space for the following remarks:—

Anyone reading the published figures would come to the conclusion that for the year's lighting of the No. 1 district of the City the Brush system will cost the ratepayers [illegible] per 1,000 candle power supplied, whereas the Crompton system would have cost them 129 10 for the same candle power. [illegible]

However, I challenge anyone connected with the Brush system of lighting to show that at any time, or under any conditions whatever, the Brush light, valued at 2,000 candles, ever approached one-fourth of the power of the single light, given by the A. Gramme machine, which is usually valued at 4,000 candles. I will go further, and state publicly that had not the Brush system been withdrawn from the competitive trials at Glasgow, the fact would then have been made patent to the world that, under equal conditions of measurement—if 1 H.P. used in the Gramme system gives the light 1,000 candles, 1 H.P. used in the Brush system gives the light of 300 candles only. These figures may be increased or diminished, but the proportion between them remains as above.

The facts and figures are far less favourable to the Brush system than this, but I have preferred to keep on the safe side.

If these figures had been applied to the estimation of candle-power in the city tender, the Crompton system would have been found to be far cheaper than the Brush for equal light supplied.—

Yours, &c.,

R. E. CROMPTON.

Mansion House-buildings,
Queen Victoria-street, Nov. 24, 1880.

Working Hours and Industrial Efficiency.—Prof. Henry J. Spooner, C.E., who delivered a Chadwick lecture at Gretna on Friday on "Fatigue and the Worker: Causes, Effects, and Reliefs," said that maximum output depended on the physical state of the worker, the conditions under which the work was done, and the number of hours worked.

The success of women in operations hitherto regarded as men's tasks has been remarkable, and a distinguished engineer had declared his conviction that, given two more years of war, he could build a battleship, from keel to aerial, entirely by women labour. Observation and experience had shown that when the working hours were too long, fatigue toxins developed, and weariness reduced exhilaration of effort, increased nerve strain, and induced breakdown. The gross output was increased when long hours were reduced; so the problem to be solved was what length of working day was, on the whole, most economical and best for the worker. His investigations had tended to prove that the abolition of Sunday work, and the shortening of working hours, with more general adoption of short intervals of rest varying in length and frequency with the work done would still further increase output, and other conditions remaining the same; but there were obvious difficulties in arranging that in practice. He warned his audience that working hours should not be reduced below a reasonable workable and profitable limit. The eight hours working day for all but exceptionally strenuous trades was little short of an ideal span, and workers should supplement the provisions and concessions of employers by building up their physique and vital powers. The nation's economic recovery from the devastating effects of the war would depend upon the fullest use being made of its human resources.

Developments in Engineering.—In a lecture delivered before the Austin Technical Society on the 21st inst., Prof. F. C. Lea, of Birmingham University, said the development in mechanical, electrical and constructional engineering during the last 150 years had been very remarkable. He expressed the hope that in the near future the perplexities of Birmingham with regard to cheap light and power would be solved by a great power station somewhere in the Staffordshire coalfield.

If such a central power station [illegible] was placed in the centre [illegible] not only could the coal [illegible] be used, but there should be [illegible] be pumped for use in Birmingham [illegible] of steam and for condensing [illegible] the application of [illegible] yet sufficiently [illegible] the future with [illegible] In the [illegible] trained men and properly [illegible] operation with the [illegible]

PARLIAMENTARY INTELLIGENCE.

TEACHING OF SCIENCE.

In reply to a question in the House of Commons on the 22nd inst., Mr. H. Lewis said that the Committee appointed to inquire into the teaching of science had met on 42 days and its sub-committees on 25 days. The Committee on the teaching of modern languages had met on 38 days and its sub-committees on 20 days. It was hoped that the reports of the Committee's would be ready in the early part of next year.

PARLIAMENTARY NOTICES.

The following notices have been given of intention to promote Bills and Provisional Orders in the ensuing session of Parliament :—

ELECTRICITY SUPPLY BILLS.

County of London Electric Supply Co. : To enable company to pay interest out of capital, to extend time for purchase and for extended use of lands in Barking, to extend time limited by Romford District Electric Lighting Order, 1913, &c.

Gloucester Electric Power Co. : To acquire lands and to construct generating station, to carry on business as manufacturers of gas and residual products, to extend periods of time limited by Gloucester Electric Power Co., 1902, to enlarge powers with respect to the supply of electrical energy, to enter into agreements as to rates, &c., and to make provision as to transfer to the company of undertakings of local authorities, to enter into agreements with various undertakers for mutual assistance, to authorise supply of electricity within and beyond areas of supply of company and of authorised undertakers, &c.

Rotherham Corporation : To acquire electricity undertakings of Mexborough & Swinton Tramways Co. in Rawmarsh and Swinton, to extend area of electricity supply to include the urban districts of Greasborough and rural districts of Rotherham and part of rural district of Wortley, to erect overhead electric lines, to repeal and exclude provisions relating to future purchase by local authority, to acquire neighbouring electricity undertakings, to supply electricity in bulk, to enter into agreements for the purchase and supply of gas and electricity in bulk, to purchase coke oven and crude gas, &c.

Pontypool Gas and Water Co. seek power to acquire the undertaking of the Pontypool Electric Light & Power Co., to supply electricity in the borough of Pontypool, to erect and work generating stations, to authorise company to enter into agreements for the supply of electricity in bulk within and beyond the electricity supply limits, &c.

Bristol Corporation : To extend boundaries of city, to repeal electric lighting orders in added area, and to extend Corporation's area of supply of electricity, &c.

In the South Metropolitan Gas Co.'s Bill power is sought in regard to the supply of electrical energy in bulk or of heat or power.

In the Aldershot Gas, Water and District Lighting Bill power is sought to extend areas of supply of electricity and gas of the Aldershot Gas, Water & District Lighting Co., to use certain lands for the generation, transforming and use of electricity, to transmit electrical energy to company's electricity station in the parish of Aldershot, &c.

ELECTRIC TRACTION BILLS.

London United Tramways (Ltd.) : To postpone date for compulsory purchase of tramways and light railways by local or other authorities, to make provisions as to terms of purchase, to enter into agreements with local and other authorities, to increase maximum tolls, fares and charges, to relieve from payment of annual and other sums to local authorities, to abandon parts of undertaking, &c.

Morecambe Corporation seek power to enable them to work and run in conjunction with their tramway undertaking motor omnibuses within the borough of Lancaster, the urban districts of Heysham and Carnforth, &c.

In the Bill of the Ipswich Dock Commission power is sought to construct tramroads which are to be worked by electric or other mechanical power.

ELECTRIC LIGHTING PROVISIONAL ORDERS.

Halifax Corporation (extension to urban districts of Luddenden Foot and Mytholmroyd) ; Leicester Corporation (acquisition of lands, &c.) ; Crompton, Braintree, Greasbrough, Royton and Stockbridge Urban Councils ; Lees Urban Council (to supply electricity and take supply in bulk from Oldham Corporation) ; Electrical Distribution of Yorkshire (for Wortley rural district).

SCOTTISH PROVISIONAL ORDER.

British Aluminium Co. : To construct waterworks, &c., in the county of Inverness, and to divert, appropriate and use power of waters of Lochs Laggan and Treig, and to erect station for development of water-power and generating and producing electrical energy, to establish manufacturing works, &c.

Electric Furnace Progress. At present there are about 144 Heroult electric furnaces in operation or contracted for in the United States and Canada. Licences for the erection of nine Heroult electric steel furnaces were recently granted by the United States Steel Corporation to three private firms and to the Watertown Arsenal.

ACID AND WATERPROOF LAMPHOLDER.

Messrs. Ward & Goldstone, of Sampson Works, Salford, Manchester, have recently issued a leaflet giving particulars of their "Sampson" acid and waterproof lampholder which has been specially designed for use in dye works, chemical works, steam sheds and in other places exposed to the corrosive action of acids or steam. Copies of the leaflet (No. 101) may be obtained on application to the firm.

The shell of the holder is made of strong vitreous acid-resisting porcelain, fitted with an acid-proof rubber shield which effectively protects

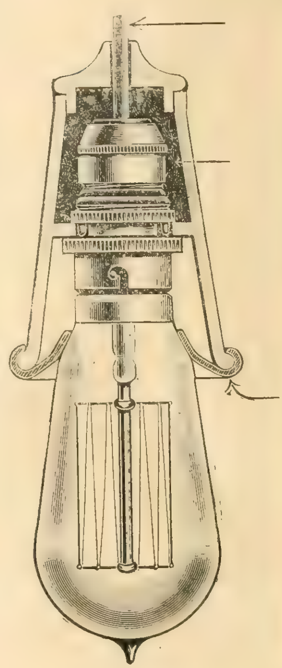

FIG. 1.

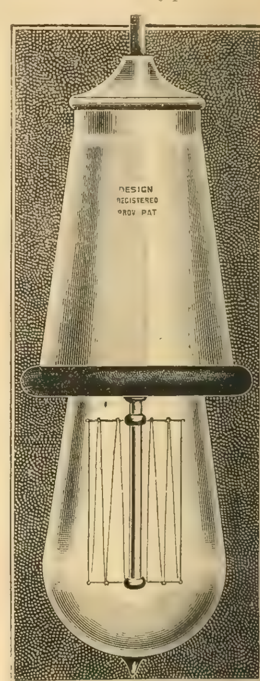

FIG. 2.

the lamp-cap and interior lampholder from the effects of dampness and corrosion. The top of the porcelain holder fits on loosely after wiring, enabling the top chamber of the interior to be filled with a sealing compound, such as paraffin wax. The cap is then dropped back into its position, when the sealing compound is plastic. The interior lampholder is locked in position in the porcelain shell by means of two shade rings, the upper ring having projecting claws which fit into a slot in the porcelain and prevent the lampholder from turning round in the shell when screwed into position. Among the special advantages claimed for the holder are ease in wiring, reliability and effectiveness. The holder is arranged to take standard tough rubber jacketted flexible cord. Prices and particulars, with samples of the holder, can be obtained on application from the firm. The first illustration shows the chamber into which the sealing compound is poured and also the acid and waterproof shield, hermetically enclosing the brass lamp cap and the lampholder, while in the second illustration a view of the complete lampholder and lamp are shown.

NEW ZEALAND TELEGRAPHS AND TELEPHONES.

The following information is abstracted from the report of the New Zealand Post and Telegraph Department for the year ended March 31 last:

The total of the telegraph revenue (including telephone exchanges and miscellaneous receipts) amounted to £814,521, an increase of almost 0.88 per cent. Including Government telegrams, the total was £8[illegible],298. Ordinary telegrams decreased from 6,032,131 to 5,712,739, and bureau messages increased from 3,963,801 to 4,382,823. The extension of telegraph and telephone lines proceeded steadily during the year. Forty new offices were opened, making the total 2,409. Of these, 337 are Morse telegraph offices and 2,072 telephone offices. Telegrams of all classes were [illegible], increase 38,369. While ordinary telegrams decreased in number, the increased rates produced an increased revenue of [illegible]. Press telegrams fell from 383,155 to 304,192, but the revenue was £25,553, against £21,417. There are 13,896 (compared with 13,684) miles of pole line and 50,320 (48,052) miles of wire for telegraph and inter-

urban telephone services, and 3,897 (3,427) miles of pole line, and 142,469 (128,525) miles of wire in the telephone exchange system.

There was no alteration in the length of submarine cable (374 knots). The Centre Island to Colac Bay cable developed a fault, repairs to which were not effected, as it was considered that it would be more economical to substitute a wireless telephone system to operate between Centre Island and Awarua, in conjunction with Puysegur Lighthouse. Arrangements were made for the transfer of the terminus of the Eastern Extension Co.'s cables from Wakapuaka to Wellington, and two new extensions of submarine cable (about 80 miles each in length) were laid between Titahi Bay and the point from which the extensions are connected to the existing cables. An underground section of the cable from Titahi Bay to Wellington, a distance of about 16 miles, has also been laid.

The Pacific cable route, which in the previous year handled 67 per cent. of the ordinary outward business, received 71 per cent., while the Eastern Extension Co.'s proportion decreased from 33 per cent. to 29 per cent. Ordinary telegrams forwarded by the Pacific route were 114,718, and by the Eastern 47,790.

Messages received from international stations increased 25·13 per cent., and there was a decrease of 12·34 per cent. in the traffic received from Australia. 492 Press telegrams were sent via Pacific and 1,423 via Eastern, compared with 963 and 1,542 respectively last year. The number of cables sent as "deferred" increased 10·77 per cent., and the number of week-end and Expeditionary Force messages forwarded from New Zealand decreased 0·39 per cent., the total number of messages for 1916–17 and 1915–16 being 28,277 and 28,387 respectively.

WIRELESS TELEGRAPHY.

The working of the wireless stations continues to be satisfactory. Improved methods of detecting signals by means of the ultraudion were introduced at Awarua, Wellington and Auckland a few months ago, and apparatus for the other stations has been procured and will shortly be brought into use. The results obtained at Awarua, where the apparatus has been extensively experimented with, have been particularly gratifying. The signals of stations using damped and undamped waves invariably come in of readable strength from American, Asiatic and European stations. The use of this detecting apparatus with a particular combination of the receiving circuits has demonstrated that daylight signals from stations using the ordinary wave-lengths can be rendered plainly audible, which by the ordinary methods and the use of the crystal detector could not be heard. The volume of wireless traffic is still being kept restricted, owing to requirements arising out of the state of war. Twenty-one ship-stations are registered in New Zealand.

As indicating collateral uses which wireless stations may serve, "time" was transmitted to the Observatory clock, Wellington, to Tahiti. The clock was arranged to make contacts at intervals of a minute, and worked a relay at Awanui over a land-line about 600 miles long, the relay in turn operating a sounder which served as a key to work the high-power transmitting apparatus. Ten separate signals which were sent were reported as having been received in an entirely satisfactory manner at Tahiti, the distance covered being 2,245 nauts. The wireless working with Apia, Samoa, is being satisfactorily maintained.

TELEPHONE EXCHANGES.

Ten new telephone exchanges were opened and two closed, and subscribers increased by 4,250 and connections by 3,547. There are 267 exchanges, of which 62 are central and 205 sub-exchanges. The total number of connections is 62,523, increase 6·01 per cent. Telephone revenue was £317,275, increase £29,728. The conversion of earth-working exchanges to metallic circuit is steadily proceeding. Of the existing exchanges, 208 are on the metallic circuit system, 38 on the single-line system, and 21 are in course of conversion from single line to metallic. There are 3,149 party line circuits, with 10,661 subscribers (increase [illegible] lines and 2,156 subscribers). The adoption of a superior type of repeater coil has increased the working range of several trunk [illegible] lines. Code ringing has been superseded in favour of [illegible] on these lines. The system has proved its efficiency and will be extended. [illegible] new slot telephone installations have been made, making the total 237. It is found that when these instruments are erected in business centres the revenue pays for the management and upkeep, while the reverse is the case in residential areas.

The completion of the installation of those automatic exchanges that were in progress at the end of last year has not yet been effected. The delay has been due to the non-arrival of material arising out of the war conditions. It will be some time, under existing conditions, before the new automatic exchange at Featherston-street, Wellington, will be available. In the Auckland telephone area the bulk of the material for the three exchanges of Remuera, Ponsonby and Mount Eden has been received, and a start is being made to erect it. At Christchurch the situation is very much as it was last year, except that the building for the accommodation of the automatic equipment at St. Albans has been completed.

INDUSTRIAL PROBLEMS IN THE U.S.A.

At the Convention of the Chamber of Commerce of the United States, which was recently held at Atlantic City, resolutions were passed on the subject of water-power development, price revision, the Federal Trade Commission, daylight saving, co-operation for export trade and Government purchases, price control and priority of shipments.

On water-power legislation the Chamber of Commerce passed the following resolution:—

"Whereas the scarcity of coal and other fuels during the past year, with the resulting disastrous effect on every branch of commerce and industry, calls renewed attention to the great importance of developing at the earliest possible day unused water-power in order to make available for public service an inexhaustible power not requiring the consumption of exhaustible power, and

"Whereas increased use of water-power, because it furnishes a cheap and reliable power of general application, reduces the drain on our stores of mineral fuel which when consumed can never be renewed, and thereby relieves a great stringency bearing on national defence due to the imperative need for fuel for both land and water transport and the manufacture of war supplies; be it therefore,

"Resolved, That Congress should without delay enact legislation necessary to the early development of water power at sites now under federal control on terms which will advance and protect the public interest; also

"Resolved, That the directors appoint a special committee to investigate this present need of water-power development and the character and extent of legislation required and report to this chamber as promptly as possible."

Another resolution set forth the great need of development of public land water-power sites.

The Chamber also favoured Government fixing the prices of essential products, and it was urged that such board or boards as had the responsibility of fixing prices should afford opportunity to industries affected to present changes in cost of production in order that such fixed prices might be revised when necessary thus maintaining the proper relation between the cost of production and the fixed prices.

Action by Congress and the President was urged in order to make the daylight plan effective as a war measure.

Resolutions relating to the great importance of legislation to permit co-operation for export trade were reiterated, and the Senate committee on interstate commerce was asked to report for consideration the Webb-Pomerene bill for promoting export trade.

The Chamber of Commerce holds that all Government war buying should be assembled under the control of one board or executive department, which should have full power to procure war supplies to the best advantage to the government as to price, quality and delivery and in a way to maintain essential industrial life without disturbing social and economic conditions, including the power to fix prices not only to the Government but to the public on essential products and to distribute output so as to promote the national defence and the maintenance of the industrial structure.

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

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CONTENTS.

NOTES.

The Electrical Contractors' Association's Guarantee.

The Electrical Contractors' Association has at length taken the important step of guaranteeing the work of its members. This project has been under discussion for a considerable time, but various difficulties have arisen. One of these was due to the fact that the Board of Trade were of opinion that the new proposals were inconsistent with the charter of incorporation of the Electrical Contractors' Association. This difficulty has been overcome by forming the N.E.C.T.A., Ltd., and through this Association guarantees are now to be given in regard to good workmanship and materials. We understand that all work will be carried out in accordance with the rules of the Institution of Electrical Engineers with a few small exceptions, the chief exception being that non-Association cable may be used provided that it is made by members of the Cable Makers' Association. From the Articles of Association of the new Company we find that the limit of liability is fixed at £50 in respect of any one client. We are informed that the work which the new Association has in mind excludes ship work and mining work [illegible] the liability is comparatively small. It is quite [illegible] no doubt, in the case of the smaller class of [illegible], but would be insufficient where the work is of any magnitude. From the point of view [illegible] would be better to have the indemnity in the shape of a [illegible]. According to the Articles the sum which may [illegible] is recoverable from the member, and if that member refuses to pay he may be expelled from the Association. Another point of [illegible] is that the period of the guarantee is limited to six months from the time when the wiring is [illegible]. So short a period, it seems to us, very much limits the value of the guarantee, because [illegible] do not show up in the [illegible] period. It is expressly laid down [illegible] to advertise the fact that their work is guaranteed [illegible], and these are so general that the client, unless he takes the trouble to inquire, might think that the work is guaranteed to any amount. It appears to us that the value of the guarantee is very much reduced by the limitations we have pointed out. Perhaps its chief value will be in making the members [illegible] up thoroughly to the rules of the Institution of Electrical Engineers, and it will be doubly valuable if municipal engineers will support the scheme, as they should. We are glad that a beginning has been made in guaranteeing the good quality of materials and workmanship, but we hope that as the result of experience the guarantee will before long be made more substantial and effective.

Defective Meter Reading.

In another column we report a case which is of some interest to the electricity supply industry. A meter on the premises of a consumer connected to the mains of the Hendon Electric Supply Co. was replaced by a new meter which, in fixing, was incorrectly connected up, with the result that no registration took place. After two quarters, during which time no electrical energy was apparently used, the Company came to the conclusion that something was wrong, and upon investigation they found that a connection had been omitted. An application was then made for payment on the basis of the consumption in corresponding quarters of the previous year. This, we believe, is an acknowledged method in such cases. The consumer, however, refused to pay and the matter was taken into the County Court, where the Judge gave judgment in favour of the consumer, on the ground that an electrical inspector as provided under the Company's Provisional Order should have been called in before the account was rendered. The case has now been taken to a Divisional Court and the judgment of the County Court judge has been confirmed, but with an intimation that an inspector may still be called in to settle the matter. It is not every consumer who is prepared to invoke the aid of the law in [illegible], but cases of this kind may arise from time to time, and if a distinct procedure has been laid down it is just as well that supply authorities should adopt [illegible] unnecessary controversy. [illegible] if a larger number of [illegible] to be available at the present [illegible].

Electricity and Medical Treatment.

In [illegible] to the need for care in selecting the services of those professing [illegible] has proved its value [illegible] to the medical profession, special impetus having been given to this branch of work by the war. Under proper medical supervision, electro-[illegible]

trical processes. Many of the so-called "electric" devices have nothing electrical about them. It is, perhaps, too much to ask that the exploitation of such methods by unqualified persons should be condemned by law, though when the treatment has become more completely standardised this step would seem desirable. The most hopeful means of combating imposture in this field lies in a wider dissemination of knowledge of electrical matters, and a more general scientific education. Meantime a closer union between medical men interested in such treatment and those responsible for the manufacture of electro-medical apparatus seems desirable. In some cases the apparatus is constructed with a surprising indifference to electrical laws, and while it apparently is of value to the medical profession, it could doubtless be made more so by efficient design. Medical men, too, not infrequently lose opportunities of acquiring valuable knowledge through neglect to measure accurately the currents with which they are dealing. Some steps to facilitate closer intercourse between those concerned respecting the medical and electrical side of this work—such as those recently proposed in connection with Röntgen ray treatment—would seem desirable, especially in view of the fact that this field of work offers such rich possibilities in further research.

Restrictions.—We would ask our readers to excuse the smallness of this week's issue of THE ELECTRICIAN. We shall be publishing a much larger number of pages than usual next week, and, unfortunately, present conditions do not admit of pre-war standards.

Royal Society.—At the meeting held yesterday Dr. Alexander Russell read a Paper on "The Electrostatic Problem of a Conducting Sphere in a Spherical Cavity." Some other Papers of general physical interest (but not electrical) were also read.

Institution of Electrical Engineers.—Members of the Institution of Electrical Engineers will be interested to know that the disciplinary matter discussed at the special general meeting of corporate members of the Institution last week remains in abeyance.

Royal Institution.—A general meeting of the members of the Royal Institution was held on the 3rd inst., Sir James Crichton-Browne, F.R.S., treasurer, in the chair. The chairman announced that the managers at their meeting held that day had appointed Dr. Arthur Keith, M.D., F.R.S., Fullerian Professor of Physiology. Dr. Arthur Keith is Conservator of the Museum at the Royal College of Surgeons, and author of "The Human Body," and other well-known works.

Books for British Prisoners.—We have received another appeal for books for British Prisoners of War. The effort needs no support from us, for it is obviously desirable to give these unfortunate men some mental occupation. If any reader writes to Mr. A. T. Davies, C.B., at the Victoria & Albert Museum, South Kensington, London, S.W. 7, he will no doubt receive a list of the technical books at present desired.

A Lamp with a Renewable Filament.—The "Electrical World" contains a summary of a recent patent specification relating to a form of lamp with a renewable filament. The lamp is [illegible] gas-filled type, and is so made that the globe can be removed to [illegible] the removal of the old filament. After a new one has been inserted the globe is attached with a joint tight enough to retain the gas included. The globe is [illegible] into position and a screw plug is provided which can be removed in order to enable gas to be introduced.

Improvements in Sealing Dry Cells.—A recent French patent [illegible] by G. L. Tarver deals with the sealing of dry [illegible] cells with a view to preventing deterioration and to economising [illegible]. In the ordinary arrangement the cell is sealed by pouring in wax at the top with a thickness of 1 cm. to 2·5 cm. This has the drawback of masking a certain area of the active material, and thus diminishing the output of the cell. Moreover, in hot countries, or in cases where the cell is exposed to somewhat high temperatures, there is a danger of the wax melting, and thus allowing the volatile elements to avaporate. The arrangement which is the subject of this patent utilises a zinc cap, which is connected to the outer zinc case, thus forming one electrode. A small central aperture is left for the insertion of the carbon, and only a small amount of wax is required to keep this in position and insulate it from the surrounding zinc cap.

Colour Temperature Scales.—In the "Physical Review" Messrs. E. P. Hyde, F. Cady and W. E. Forsythe discuss the relations between the "colour-temperature," the "brightness temperature" (*i.e.*, the black body temperature) and the true temperature, on which a number of researches with tungsten and untreated carbon lamps were undertaken. The colour-temperatures are plotted against direct observations from a black body carbon-tube furnace. The colour-temperature is in general higher than the value obtained from a consideration of brightness only, while the latter, as is well known, is less than the true temperature of incandescence. Observations based on colour thus come nearer the true temperature. The relation between watts and colour temperature is found to be an exponential one, but it is shown that for tungsten the exponent cannot be a constant but decreases slightly at the higher temperatures.

Electricity and the Hygiene of the Body.—The third of the Chadwick Lectures on "Electricity and National Welfare" was given at the Museum, Leicester, on Dec. 1, by Prof. H. T. Davidge, the special subject dealt with being "Electricity and the Hygiene of the Body." The lecturer discussed electric shock, distinguishing between safe and dangerous pressures, and referring to the effect of frequency of alternation. This led to an explanation of the harmless character of high frequency currents. Subsequently the applications of electricity for medical treatment were discussed in some detail, the nature of ionic medication, brush discharges, electric baths, galvanic and faradic currents and Röntgen rays being explained. An interesting development since the war is the improvement of magnetic methods of removing foreign bodies from wounds. Electric treatment requires to be given under careful supervision by men well versed in the subject, for ignorant and unskilled persons not infrequently impose electric devices on a public to whom "electricity" and "radium" may mean anything whatsoever.

The Mineral Oil Resources of the Empire.—As is well known, the demands for mineral oil since the outbreak of war, not only for motor locomotion in general but especially for such special purposes as the propulsion of aeroplanes, tanks and submarines, has been enormous, and it is natural that supplies of oil within the British Empire should be sought in all directions. The oil resources of the Empire recently formed the subject of a lecture by Prof. Brame at the London School of Economics, in the course of which it was remarked that India contributes by far the largest proportion of the output of the Empire, amounting to approximately one million metric tons per annum, of which the bulk comes from Burma. Trinidad and Barbados have recently come to the fore, the output from the former reaching over 32 million gallons in 1916, while the resources of the latter have yet to be fully explored. Canada furnishes a not inconsiderable oil supply, while Egypt, New Zealand and North Borneo are also promising sources. The most important instance of oil production in the British Isles is the Scottish shale oil industry; similar shales exist in Dorset, Norfolk and elsewhere. Considering the whole position of the Empire in relation to the world's supply of oil, the British production probably does not amount to more than 2·4 per cent., of which nearly 2 per cent. comes from India. In the present circumstances there is therefore every inducement for British Colonies and dominions to ascertain and develop their local oil resources.

Diesel Engine Users Association.—At the November meeting of the Association, the President (Mr. Geoffrey Porter) reported that the Standing Committee on Insurance against Breakdown were drafting by-laws to regulate its procedure and to deal with differences that might arise between the underwriters and policyholders in the interpretation of the standard policy, &c. The recent Order of the Ministry of Munitions regulating supplies of tar oil for use as fuel in Diesel engines was considered and discussed. Comment was made on the condition in the schedule that acceptance of the producers' weights and measurements in selling tar oil should be compulsory on the purchaser. It was reported that the Controller of the Mineral Oil Production Department of the Ministry of Munitions was arranging for trials of mixtures of pitch and creosote to be carried out with a view to their adoption for use as fuel for Diesel engines. The hope was expressed by the meeting that actual users of Diesel engines under normal working conditions should be given an opportunity of thoroughly testing any such fuel and reporting thereon before any final decision was arrived at by the Controller as to its suitability. Mr. George W. F. Horner read some notes on "The Lubrication of Air Compressors." A communication from Mr. J. Veitch Wilson on the subject of "Lubrication of Air Compressors and Diesel Engines" was also read.

A New Insulating Material.—A new type of insulating material for which special properties are claimed is described in the "Revue Générale de l'Electricité." Besides having good insulating properties it can be moulded to any desired shape, and cut, or worked either by hand or machine. It is also practically incombustible, non-absorbent and does not require to be varnished. It is considered suitable for many electrical applications for which porcelain, marble and various vulcanised preparations are at present employed. The cost is also stated to be relatively low. The material is said to have the following constituents :—

Powdered flax	51·7	per cent.
Sifted mica	14	,,
Mineral rubber	20	,,
Resin	1	,,
Rubber solution	10	,,
Flowers of sulphur	3	,,
Selenium bisulphide	0·3	,,

The selenium bisulphide is used only as a suitable binding material, which facilitates the combination of the other ingredients, and evaporates when the substance is left in the air after mixing. Carbon bisulphide may also be employed. The other substances are all capable of close mixing. The "mineral rubber" recommended is a soft mineral deposit which occurs in certain oleaginous schists. The proportions of the materials may be varied within certain limits according to the use to which the material is to be put. After the substance has been dried it can be softened by being immersed in a steam jacketed vessel. When thus reduced to the plastic state it can be compressed into any desired form.

Telephone Connections on the Eastern Front.—"L'Industrie Electrique" comments upon an interesting development in methods of electrical communication between headquarters and the men in the trenches, namely, the use of wireless to a degree unexpected previous to the war. It was formerly assumed that wireless methods of communication would be unsuitable in such circumstances owing to the ease with which messages can be intercepted by the enemy. The tendency has therefore been to rely mainly on telephone connection, notwithstanding the ease with which the connection may be ruptured by bombardment. The destructive effect of modern artillery has made the ordinary method of laying wires along the surface of the ground or attaching them to trees of limited utility. Even buried wires are apt to be destroyed at an inconvenient moment by explosive shells, and therefore the depth at which such wires are buried has become continuously greater and the methods of protection more elaborate. The Germans have sought to get over this difficulty by laying a regular network of interconnected lines, so that in the event of several being damaged there is still a path for the current. Even this precaution, however, may fail in a modern bombardment, and the Germans now appear to be relying to a much greater extent on wireless communication. The article to which we refer quotes particulars which are said to apply to the latest German practice, according to which it would appear that the antennæ are mounted 4 metres above the surface, are about 100 metres long and emit waves of 300 to 600 metres. On the Eastern front about 110 wireless detachments are said to be employed.

PERSONAL.

Mr. T. L. Horn, M.I.E.E., has removed to Nithsdale, 125, Bethune-road, Stoke Newington, London, N. 16.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, Dec. 7th (to-day)

JUNIOR INSTITUTION OF ENGINEERS.

8 p.m. At 39, Victoria-street, London, S.W. 1. Paper on "Maintenance of Engineering Plant," by Mr. J. G. Moon.

MONDAY, Dec. 10th.

ROYAL SOCIETY OF ARTS.

4.30 p.m. At John-street, Adelphi, London, W.C. Cantor Lecture on "Progress in the Metallurgy of Copper," by Dr. H. C. H. Carpenter. (Lecture II.)

TUESDAY, Dec. 11th.

INSTITUTION OF ELECTRICAL ENGINEERS, MANCHESTER LOCAL SECTION.

7 p.m. At the Engineers' Club, Manchester. Paper on "Electrical Cooking as Applied to Large Kitchens," by Mr. W. A. Gillott.

INSTITUTION OF ELECTRICAL ENGINEERS, STUDENTS' SECTION.

7 p.m. At King's College, Strand, London, W.C. Discussion on "Recent Applications of Electricity."

ASSOCIATION OF SUPERVISING ELECTRICIANS.

7.15 p.m. At St. Bride Institute, Bride-lane, Fleet-street, London, E.C. Paper on "Transformers," by Mr. A. J. Cridge.

INSTITUTION OF ELECTRICAL ENGINEERS, SCOTTISH LOCAL SECTION.

7.30 p.m. At the Rooms, 207, Bath-street, Glasgow. Paper on "Gas Firing Boilers," by Mr. T. M. Hunter, M.A.

WEDNESDAY, Dec. 12th.

ROYAL SOCIETY OF ARTS.

4.30 p.m. At John-street, Adelphi, London, W.C. Paper on "Technical Training for Disabled Soldiers and Sailors," by Lord Charnwood.

FARADAY SOCIETY.

7.30 p.m. At the Chemical Society, Burlington House, Piccadilly, London, W. Annual general meeting, followed at 8 p.m. by an ordinary meeting, at which the following Papers will be discussed : "Note on the System of Recording Rate of Chemical Reaction," by Mr. J. W. McBain ; "The Effect of Hydrogen Chloride on the Nitrogen-Hydrogen Equilibrium," by Mr. E. B. Ludlam ; "The Influence of Carbon Monoxide on the Velocity of Catalytic Hydrogenation," by Dr. E. B. Maxted ; "The Viscosity of Blast Furnace Slag and its Relation to Iron Metallurgy : A New Method of Measuring Slag Viscosity at High Temperatures," by Mr. A. L. Feild. The following Papers will be read : "A Study of the Refractivities of Saturated and Unsaturated Compounds, Parts I and II," by Mr. G. Le Bas ; "The Thermal Properties of Sulphuric Acid and Oleum," by Dr. A. W. Porter, F.R.S., and "On Isopiestic Solutions," by Mr. W. R. Bousfield, F.R.S.

ASSOCIATION OF ENGINEERS-IN-CHARGE.

8 p.m. At St. Bride Institute, Bride-lane, Fleet-street, London, E.C. Paper on "Some Points of Modern [illegible]," by Mr. A. W. W[illegible].

THURSDAY, Dec. 13th.

INSTITUTION OF ELECTRICAL ENGINEERS.

6 p.m. At the Institution of Civil Engineers, Great George-street, Westminster, London, S.W. Discussion on "The Meter Section," with introductory Papers by Messrs. [illegible] and A. J. Stock.

FRIDAY, Dec. 14th.

INSTITUTION OF MECHANICAL ENGINEERS.

6 p.m. At the Institution of Civil Engineers, Great George-street, Westminster, London, S.W. Paper on "[illegible]," by Messrs. A. A. [illegible] and C. E. [illegible].

[illegible] SOCIETY.

8 p.m. At [illegible], London, W.C. [illegible] Mr. [illegible].

ELECTRICAL COOKING AS APPLIED TO LARGE KITCHENS.*

BY W. A. GILLOTT.

Owing to the favourable tariffs now in force in most districts, electrical cooking in large kitchens is now a sound commercial proposition. By large kitchens the author means more particularly the class of kitchen met with in restaurants and in works or other large business premises when staff-feeding is required for a large number of employés. The author considers the future of this branch of electrical industry to depend, first, upon close co-operation between the supply company's engineer and the manufacturer, and, secondly, upon the interchange of ideas and experiences between different supply companies and municipal engineers who have the plant actually running on their own mains. This Paper has therefore been prepared in the hope that the facts and illustrations given may be of use to others who are engaged upon or are considering similar work: also to show that electrical cooking is not only extensively used in large kitchens, but also found to be reliable, efficient and economical. The figures given have been obtained under ordinary working conditions, and in some cases without the knowledge of the cook using the apparatus. They can therefore be taken as a basis for similar installations working under somewhat similar conditions.

In drawing up a scheme for cooking in large kitchens, the essential items are: (1) Reliability, (2) quick service and (3) efficiency.

Reliability.—Under this item the question of electrical distribution from the service cables is as important as the electrical work on the apparatus itself. This is more so at a restaurant where there are serveries on different floors, quite apart from the kitchen, than in an establishment where staff-feeding is only required with the kitchen adjacent to the dining rooms. In the latter case a cable from the service to the distributing centre in or near the kitchen is all that is required; but in the former case, especially where the total loading of the apparatus in the serveries is appreciable, two pairs of cables should be brought from the service, which on large installations should be the main distributing centre, to each servery and kitchen. This system, in the author's opinion, is better than balancing one servery or kitchen against the other, as in the event of a fault developing on the mains only a section of the apparatus will be put out of commission. These cables should terminate in a double-pole switch of ample size and single-pole fuses of the replaceable pattern, and connections be provided to supply through branch single-pole fuses to the various pieces of apparatus, each of which should be controlled by a double-pole switch adjacent to the same.

The apparatus itself must be of solid construction and designed to stand hard and continuous wear, and be efficiently earthed. All switches and fuses must be fixed on a separate board within easy reach of the chef, and each section of the apparatus should be fitted with a switch, fuse and indicator. The internal wiring of the apparatus must be so fitted that it is practically impossible for steam to penetrate through to the insulation. On well designed apparatus solid type connections are employed and where a connection is required from, say, a hot-plate to the terminal chamber, the wiring may be run in solid-drawn tubes direct from the hot plate case to the terminal box, this being fitted well up and away from any position likely to be affected by liquids boiling over. It will be seen that, by this method, flexible metallic tubing is dispensed with, thereby removing a weak link.

All elements except the grills should be connected in series parallel, and where possible they should be so arranged that after the cooking has thoroughly commenced, they can be switched to "low" and provide sufficient heat to complete the operation. Under these conditions the elements are running at quarter load during the majority of the time, with the result that the elements have a much longer life than if parallel elements were employed throughout.

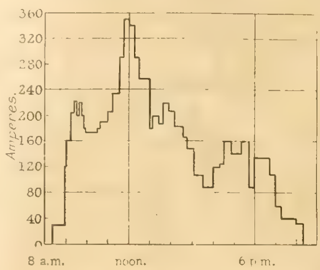
On apparatus where the heating elements are clamped under pressure, such as hot plates, water boilers, stock pots, steamers, &c., the pressure plates should be made of strengthened cast iron in preference to wrought iron, in order to prevent them from buckling and causing uneven bearing surface on the element. The element should cover as much surface as possible, as concentration of heat on one part of the class is likely to cause premature failure. On apparatus where the loading is comparatively high, it is advisable to employ cast iron or steel bottoms in place of copper. Instances have occurred in the author's experience where the adoption of cast-iron and steel bottoms on large boiling units has overcome the trouble of premature failure.

Quick Service and Efficiency.—These two items, so far as the chef is concerned, come under one heading and can therefore be dealt with together.

In laying out a cooking scheme for a large kitchen, it is essential to arrange the apparatus so that the chef can supervise the cooking with a minimum of effort.

Where large quantities of water are required for tea-making, the author recommends that the water be raised to a temperature of approximately 160°F. by means of a coke boiler or live steam, the final boiling being carried out in self-contained electric urns, the sizes of the urns, of course, being suited to the demand.

Plate and dish-warming is a very necessary item, especially in restaurants where ample accommodation is essential. Hot cupboards for this class of work should be lagged, as they are called upon to work several hours a day, and, by conserving the heat, running costs are kept down. The question of keeping food hot is also a very important item, and in restaurants this has to be carried out in an entirely different manner from that adopted in staff-feeding establishments, where the meals are usually provided at a specified time each day. Properly designed apparatus is therefore supplied to provide the correct heat and to keep the cooked food in perfect condition.



LOAD DIAGRAM OF INSTALLATION "A."

The original Paper contains a schedule of plant, included in four installations. Table I. gives certain data in regard to these installations.

Table I.

Installation.	Period of observation.	Consumption in units.	Average number of meals per week.	Units per meal.	Cost of maintenance per 1,000 units consumed.	Kw. connected.
"A"	10 months	122,052	9,518	0·29	1s. 6½d.	247·6
"B"	1 year	97,140	2,944	0·5	2s. 9d.	130·9
"C"	1 year	21,141	991	0·41	3s. 9½d.	40·5
"D"	1 year	20,690	640	0·51	4s. 6½d.	32·8

The cost of maintenance on installation "D" is high in comparison with the others; this is due to the fact that during the last 18 months the apparatus has been catering for an increase of 100 per cent. more people than ordinarily intended.

In the analysis of maintenance (Table II.) all elements, &c., that have been supplied free under guarantee have been included at their ordinary costs, workmen's train fares have been omitted in order to make a true comparison with those installations close to the workshop.

Table II.—*Maintenance Analysis of Installations "A," "B," "C" and "D."*

Installation.	Elements. Oven.	Hot-plate.	Grill.	Urn.	Hot cupboard.	Fish fryer	Vegetable steamer.	Wiring faults.	Earthing faults terminals, &c.
"A"	4	2	7	...	...	...	...	17	4
"B"	20	16	25	5	2	3	7	27	25
"C"	...	22	1	1	...	...	...	14	3
"D"	2	28	28	...	...	...	...	17	2

Table III. gives a comparison of the initial costs of installations "A" and "B" with electrical apparatus, gas apparatus, and a mixture of coal, gas, and steam apparatus, the cost of connecting up the apparatus to the source of supply being in each case included.

Table III.

Installation	Electricity.	Gas.	Coal, gas and steam.
A	£1,146 19 0	£1,169 0 0	£1,275 0 0
B	566 6 0	188 0 0	536 0 0
C	108 12 0	98 10 0	...
D	111 12 6	104 8 0	...

The difference in the initial cost is not so much with an installation of coal, gas and steam, as with gas alone, but it would be impossible

* Paper read before the Institution of Electrical Engineers (Abstract).

to use gas apparatus only on installation "A," for instance, owing to the restricted space. The first cost is not the only cost to be considered, and should never be looked upon as the prominent factor.

When the working comparisons are considered, electricity has the advantage in almost every detail, the following being a few of the essential items which in the majority of cases when carefully gone into offer sufficient advantages to outweight any difference in capital cost: (1) 3leanliness and absence of fumes; (2) constant heating value; (3) reduced labour costs; (4) less floor space required; (5) economy in food; and (6) saving on the renewal of kitchen utensils. This is a very heavy item when coal is used for boiling, frying, &c.

The diagram shows the load curve installation "A." If those engineers who have not yet attempted the large cooking business will look around their districts, they will be surprised to see the enormous amount of revenue that awaits them from large staff feeding establishments, cafés, restaurants, &c., which will fully justify a first trial installation from which to gain experience.

THE NATIONAL ELECTRICAL CODE.

According to the "Electrical World" of Oct. 27 very few important changes were made in the National Electrical Code by the electrical committee of the National Fire Protection Association at its twenty-first annual meeting, which was held in New York on Oct. 23 and 24.

The following five recommendations of the [illegible] committee were adopted: (1) That a committee of five [illegible] to consider the use of lead-covered cables for extension [illegible]; (2) that a special committee of five be appointed [illegible] to take care of apparatus under 50 [illegible] have power to revise sections of the code [illegible]; (4) that the next edition of the code be known [illegible] 1918 edition, to be ready by Jan. 1, 1918, and that the next [illegible] 1920; (5) that a committee of five be appointed to be [illegible] new system and devices committee." The latter committee will investigate all new systems and devices, referring them to the Underwriters' Laboratories, which will make the necessary tests and investigations and refer them back to the committee.

WIRING OF POWER STATIONS [illegible]

Recommendations in the report of the committee on the wiring of power and substations were [illegible] as presented. The new paragraph on the subject of [illegible] arresters, which formerly read "on circuits of over 7,500 volts, [illegible]." Several changes were made in the [illegible] of the committee [illegible] induction motors, and the report [illegible].

Several changes were made in [illegible] cabinets. Under the rule on outlet [illegible], Section a was finally amended to [illegible] boxes having not more than 150 cu. in. (2,400 cu. cm.) contents, outlet boxes and flush switch boxes [illegible] 0.078 in. (1.98 mm.) No. 14 U.S. [illegible] having wall thickness not less than [illegible] on electric signs.

[illegible]

The committee on grounding [illegible] Oct. 15, 1917, which was adopted [illegible] wires on [illegible] except under the following conditions [illegible] insulated from the ground and from [illegible] "Insulating joint [illegible]

[illegible]

and [illegible] with polarised circuits, and that manufacturers, jobbers, contractors and all interested be asked to co-operate in securing the above results with as little delay as possible. The committee further recommends that the Underwriters' Laboratories (Inc.) be more severe in its specifications and tests on "approved ground clamps." The committee also recommends that ground clamps be made only of copper and not less than 1/16 in. (1·6 mm.) in thickness, that no iron or steel be used in any part of the clamp except that a steel clamping bolt may be used, and that the lug to which the wire is soldered or fastened by an approved connection be an integral part of the clamp.

[illegible]

In the report of the committee on fuses, switches and meter installations, Rule 23 on automatic cut-outs (fuses and circuit breakers), Sect. a, caused considerable discussion and the wording was returned to the secretary for revision. The main idea in this section, it was decided, was that all meter installations be placed together to make a workmanlike arrangement and not be scattered over the various parts of a building. In the rule on switches a paragraph was re-arranged to read as follows: "Service switches [illegible] all circuits and devices, including meters, except as provided in the following paragraph. Where service fuses and meter are combined in an approved single self-contained unit device having no exposed wiring or live parts and no parts not protected by the fuses, the switch may be so arranged or installed that it will not disconnect the meter from the supply line, provided it does disconnect all lines of the supplied house circuits."

The report of the [illegible] recommended.

[illegible]

The report of the switch and cut-out committee was adopted with a few changes. The committee reported: "In view of the misinterpretation placed on the report of the committee in the March bulletin regarding refillable fuses the committee desires to submit the following revised report:—On evidence presented to or obtained by the committee, it does not recommend any changes in Rule 68D, but presents this report with the understanding that in order to obtain additional field experience, municipal and underwriters' inspection departments may permit a continuation or extension of the use of such refillable fuses as have, in their opinion, been shown to comply with tests and specifications for cartridge fuses and to be suitable for use." Several minor changes were made in the classification and marking of switches with a rating of over 1,000 amperes. The table on spacing was re-arranged as follows:—

[illegible]

Ampere rating.	125-volt, d.c. or a.c.		250-volt, d.c. or a.c.	
	[illegible]	[illegible]	[illegible]	[illegible]
30	[illegible]	[illegible]	[illegible]	[illegible]
60	[illegible]	[illegible]	[illegible]	[illegible]
100	[illegible]	[illegible]	[illegible]	[illegible]
200 to 300	[illegible]	[illegible]	[illegible]	[illegible]
400 to 600	[illegible]	[illegible]	[illegible]	[illegible]
800 to 1,000	[illegible]	[illegible]	[illegible]	[illegible]

Ampere rating.	250-v., d.c. or 500-v., a.c.		600-volt, d.c. or a.c.	
	[illegible]	[illegible]	[illegible]	[illegible]
30	[illegible]	[illegible]	[illegible]	[illegible]
60	[illegible]	[illegible]	[illegible]	[illegible]
100	[illegible]	[illegible]	[illegible]	[illegible]
200 to 300	[illegible]	[illegible]	[illegible]	[illegible]
400 to 600	[illegible]	[illegible]	[illegible]	[illegible]
800 to 1,000	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

[illegible]

[illegible]

THE COMMERCIAL DEVELOPMENT OF ENGINEERING IN CHINA.—I.

BY S. W. B. McGREGOR, A.M.INST.C.E., M.I.MECH.E.*

China, for many centuries closed to the outside world, self-contained, self-supporting and self-satisfied, is a land of mystery no longer. An efficient postal and telegraph system is extending over the whole country, whilst there is no city or town of importance that has not been visited by foreigners for business purposes. Before the war, Peking was 12 days' luxurious travel from London, after the war this time will probably be reduced to six or seven days. One may travel in any part of China now with safety, although, away from the railways and river services, with some discomfort and at the rate perhaps of 20 to 30 miles per day. Such journeys involve the organisation of a small expedition, but have a fascination for those who like to see men and things but little changed from 2,000 years ago.

The area and population are estimated at :—

	Area (sq. miles).	Population.
China Proper	1,500,000	425,000,000
Manchuria	365,000	16,000,000
Mongolia	1,110,000	4,000,000
Tibet	700,000	3,000,000
Sinkiang	600,000	2,000,000
	4,275,000	450,000,000

The estimated population of the capital and principal towns is :

Canton	1,250,000	Soochow	500,000
Peking	1,000,000	Ningpo	450,000
Hankow	900,000	Nanking	270,000
Tientsin	850,000	Changsha	250,000
Shanghai	700,000	Chinkiang	185,000
Chungking	650,000	Amoy	115,000
Foochow	625,000	Shasi	100,000
Hangchow	600,000		

It is not easy to realise such vast figures of area and population, and in regard to the latter it is perhaps sufficient to say that about one in every four persons living in the world is Chinese.

In considering trade possibilities it is, however, not sufficient to think in numbers only, and it is the object of this article to give some idea of the actual conditions prevailing and make some suggestions for dealing with what may be called the "trade in China problem."

The history of the Chinese people is a most remarkable one. Without going into the details of this interesting subject, it is necessary to recall a few significant features. The Chinese reached a considerable degree of civilisation some 2,000 or more years ago, but since then there has been little progress or change. They have, during the last 4,000 or 5,000 years overthrown dynasty after dynasty, and in 1912, as is well known, established a Republic. They have throughout their history been subject to gigantic national disasters, such as [illegible]

[illegible] Exports … 60,915,911 [illegible]

[illegible]

A significant difference between the opening up of China and Japan has been that China was opened up as the result of naval and military operations and not of her own free will. The old spirit of opposition has passed away and that prevailing now is one of great caution and determination that "China is for the Chinese."

The country, generally, is extremely fertile and has very great mineral resources, particularly in coal and iron. The people are mostly engaged in pastoral occupations, and are, on the whole, honest, industrious, sober and cheerful. The bulk of them, however, are almost incredibly poor as regards purchasing capacity, and whatever the reasons may be for this state of affairs, the fact has to be faced in considering trade possibilities.

Public works are in an extremely backward state.

INTERNAL COMMUNICATION.

There are no roads in the Western sense, except in the Treaty Ports and a very few towns such as Peking and Mukden. The streets in the ordinary Chinese town or village are extremely narrow and ill paved, the communications between towns and villages consist chiefly of footpaths and tracks through the fields. In the present state of the people there is no desire for roads nor are any funds available for their construction and maintenance. The introduction of motor vehicles will, therefore, be on a most restricted scale for many years to come.

China is well served with waterways, both navigable rivers and canals, although the latter have been much neglected. Steam navigation is making steady progress and an immense field exists for the development of kerosene motor craft. Great efforts are being made by the oil companies to evolve various types of hulls and motors to suit the conditions and that will compete with the native sail and hand-propelled craft.

River conservancy is thoroughly organised as regards the ports of Shanghai and Tientsin. Elsewhere there is practically nothing except the abortive attempts on the Liao River above and below Newchwang, and the 1914 agreement between the Chinese Government and the American Red Cross Society, by which the latter is empowered to raise a loan of £4,000,000 for the purpose of undertaking conservancy work in the Huai River region in the Provinces of Anhui and Kiangsu.

Sanitation and hygiene simply do not exist in China. The removal of sewage by hand has been reduced to a fine art. From time immemorial sewage has been sun-dried and returned to the land forming one of the principal means of fertilising the soil. There are no immediate prospects of change, even in the larger cities.

Waterworks exist in about 17 towns. The Chinese are satisfied with their hand distribution methods, and the development of pumping installations and pipe systems will be a slow process.

Water power suitable for hydro-electric plants exists in various parts of the country, but is not, with one or two possible exceptions, situated in districts where it will be able to be used commercially for many years to come, if ever.

In regard to industrial development the three great factors are the construction of railways, legislation enabling foreigners to own land outside the Treaty ports (missionary organisations have had certain rights to own land for many years past), security of property against civil commotion, &c.

The railway position is shown in the following table and accompanying sketch map :—

Railways in operation	7,000 miles.
„ „ British share	1,300 „
„ under construction	2,300 „
„ „ British share	750 „
„ needed	6,000 „
„ „ British share	1,550 „
„ projected, anything up to	[illegible],000 „

For purposes of comparison it may be stated that the mileage of railways in the U.K. and U.S.A. is :—

U.K.	23,400 miles.
U.S.A.	255,000 „

It is obvious what a vast field exists for enterprise and the supply of engineering material in the development of China's railways.

It is the policy of the Chinese Government to own all railways, whatever the condition of the concessions under which they are constructed. The early prejudices of the Chinese against railways have disappeared and there is a strong desire and intention to proceed with a large programme, limited only by international jealousies and the finding of the necessary funds. The profits of the existing railways have, on the whole, been of a most remunerative character.

The mineral resources of China, other than iron and coal, are not so great as has been supposed, but at the same time are of very great importance. The development of these resources await transport facilities, the ability to own land, security for plant and machinery, and the enactment of satisfactory mining laws such as will attract foreign capital and at the same time preserve the jealously guarded rights of the Chinese.

SKETCH MAP SHOWING RAILWAYS IN CHINA.
[illegible]

The annual coal production is [illegible] from 10,000,000 to 12,000,000 tons, in about equal quantities of anthracite and bituminous coal.

The coal exports were in :—

1911	326,000 tons.
1912	680,000 „
1913	1,400,000 „

The only iron and steel works of any importance is the Hanyehping Iron & Coal Co., Ltd., Hankow.

In 1915 the outputs were :—

Pig iron	135,000 tons.
Rolled steel products	98,500 „
Bolts, spikes, rivets, &c.	900 „
Fire bricks	1,200 „

The Tayeh mine, belonging to the Hanyehping Co., produced 180,000 tons of iron [illegible] the principal source from which Japan derives her supplies.

The exports of iron from China to Japan in 1914 were :—

Iron ore	290,000 tons.
Pig iron	60,000 „

[illegible]

British [illegible] serious menace to the British steel trade in international markets such as China.

China's supply of [illegible] the country, comes from Japan, which exported to China in 1913 copper and copper articles to the value of about £900,000. Japan is well endowed with copper, and whilst the metal produced may not be up to British standards of purity, it is stated that the cost of production is appreciably less than in any other country.

In 1913 China exported :—

Antimony, regulus, crude and refined	[illegible]
„ ore	[illegible]
Tin, in slabs	[illegible]

ELECTRIC LIGHTING.

The electric lighting of cities and towns has great possibilities in the immediate future, this form of illumination being much appreciated by the Chinese. Up to 1914 about 60 towns had electric lighting installations, mostly supplied by German merchants on credit terms and often at cost price with a view to making profits, legitimate or otherwise, on accessories and extensions. In pre-turbine days most of the engines were supplied by Messrs. Belliss & Morcom, Ltd., whilst nearly all the boilers are by Messrs. Babcock & Wilcox, Ltd. American manufacturers are coming rapidly into the electrical business and a strong, well equipped organisation with considerable financial resources already exists in Shanghai and has ramifications in other centres.

With the exception of the larger Treaty ports most of the electric lighting plants are not well laid out, nor has much regard been paid to economy in running. Transmission and distribution are arranged on overhead systems, often of the most crude description. Peking, otherwise picturesque, is notoriously disfigured with its overhead cable system, or want of system.

The electricity works of the Shanghai Municipal Council call for special mention, apart from those of the French Municipal Council and Shanghai Native City, which are on a much smaller scale. The plant is of the most modern and efficient type and has been rapidly [illegible] under the capable direction of Mr. T. H. U. Aldridge, M.I.E.E., M.I.Mech.E. In 1914 [illegible] the demand is ever increasing. Electric radiators have been installed in over [illegible] motors for various purposes has extended enormously. Unfortunately, Shanghai [illegible]

The method of placing contracts for electric lighting plants, [illegible]

At present rates of exchange the equivalent in English currency would be £12,500 to £62,500. The official trade returns, given below, are not satisfactorily arranged from the electrical engineers' standpoint, and their chief value is in showing the comparatively small nature of the business done.

	China, 1913. Exports from Gt. Britain.	China, 1913. Imports from all countries (estimated).
Electrical machinery, excluding prime movers, boilers, &c.	£40,000	£150,000
Electrical material and apparatus of all descriptions	£150,000	£460,000

(*To be continued.*)

THE SUPPLY OF POWER OR FUEL FOR AUTOMOBILES ON HIGHWAYS.

The Institution of Municipal and County Engineers discussed this question on Friday last.

Mr. J. A. Brodie (Liverpool) said the department of the Corporation of which he had charge had about 40 motors, and they had adopted gas bags on a number of the lighter vehicles. It was possible that petrol might be more strictly kept for the military services in the future, and he therefore advised his Authority to provide a plant for compressing gas up to 2,000 lb. per sq. in., and capable of producing the equivalent of 120 to 150 gallons of petrol per day; so that when the difficulties with regard to petrol were sufficiently great they could turn on to gas altogether. The whole of the plant could be paid for in a short time, and a large saving effected, compared with petrol, particularly for heavy work.

Mr. H. E. Stilgoe (Birmingham) gave details of the arrangements at Birmingham, and said the regulation of the traffic was in the hands of the police, but the engineers could see that the standposts were not erected in the streets having the heaviest traffic. The matter of street obstruction would be negligible, except where care was not bestowed on the sites of the charging stations. The probable users of such stations would be vehicles propelled by gas and electric power, the former predominating. The matter might develop into an after war reality. The question of charging electric vehicles had not much bearing on the subject of street traffic regulation, because they took so long to charge that the most convenient charging place was the depot or power station. The gas bags were calibrated on their first fill, and the capacity was stencilled upon them, so that they could receive subsequent charges at unmetered stations. Some of the omnibuses had gas bags of 700 cub. ft. capacity, which were made of the best balloon material, this [illegible] pressure system became general the wayside stations would become fewer, [illegible] Birmingham were from 1s. for 250 ft. to 2s. for 500 ft. Electric vehicles were generally charged at night, owing to the length of time taken, [illegible] periods waiting their turn.

[illegible]

Mr. C. H. Cooper (Wimbledon) said it was a simple thing to get a clause to amend the Acts so as to enable the scheme to be carried out. Petrol had paid a fairly good tax, and if a tax were put on the gas the price might be above instead of below that of petrol.

Mr. L. D. Thomson (Cornwall County) asked whether the 60 lb. mentioned by Mr. Stilgoe referred to the cubic foot unit.

Mr. Stilgoe said the weight of the cylinder to which he had referred was 60 lb. when charged with 250 cub. ft. of free gas compressed to 1,800 lb. pressure to the square inch. This was equal to one gallon of petrol, sufficient for a five mile motor bus journey. If a motor bus could carry a 750 cub. ft. gas bag it could carry a good many cylinders.

Mr. W. N. Blair (St. Pancras) said stations could not be permitted in such streets as Oxford-street, and frontagers in adjacent streets might object to vehicles standing waiting their turn for charging in front of their premises, and the result would be that they would leave the premises and depreciation of property would ensue.

Mr. O. E. Winter (Hampstead) said the Metropolitan Boroughs Standing Joint Committee had passed resolutions expressing the opinion that each Borough Council should have the right to veto an installation within its jurisdiction.

Mr. J. Sutcliffe (Woolwich) said the resolutions submitted by Mr. Winter did not exhibit a progressive aspect towards the question. It must be recognised that motor traffic was growing, and the suggestion that the local authority should have the power of veto was ridiculous. The matter wanted deciding on different lines from that.

Mr. Willis (Chiswick) said in his district the gas company would not incur the expenditure of constructing a lay-by off the road at a spot selected by the Council, but they had provided a charging station within two miles of that point. The Government had admitted the principle of charging electrical vehicles, and he did not think they would cavil at charging with gas.

Mr. F. P. Dolamore (Bournemouth) said the gas company at Bournemouth installed three stations, of which the Council approved, and, as the Council disapproved of the site for a fourth station, the company adopted the practice of supplying gas to vehicles through a tube from a gantry over their show-room premises. He suggested that there could be no way in which, as Councils, they could interfere with companies who adopted such a course as that. He did not regard the system as permanent, as it could not compete with petrol at its pre-war cost.

A number of other speakers also took part in the discussion, and finally Mr. Brownridge (Birkenhead) proposed a resolution in favour of providing such facilities. This was referred to the Roads Committee for consideration and report.

MR. SYDNEY T. ALLEN'S ADDRESS TO THE BIRMINGHAM LOCAL SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

In his inaugural address before the Birmingham section of the Institution of Electrical Engineers on Nov. 14, Mr. Allen remarked that since the outbreak of war there had been a tendency to informality in the discussions of technical societies. This greater freedom was often desirable. Another feature had been the growing closer relationship between those associated respectively with the theoretical and the manufacturing aspects of electrical technology. The fact is becoming realised that no barrier should exist between the theorist and the practical man. It was desirable also to encourage discussion among the junior members of the profession, and he therefore advocated the formation of a Students' Section in the Birmingham area. Another suggestion was the formation of a Central Bureau or Headquarters, not necessarily a club, but some body securing the local benefits such as had followed the promotion of the Engineers' Club in Manchester.

Turning to practical developments in the industry, he referred especially to electro-metallurgical and chemical furnaces, such as those for the smelting and refining of metals, and the making of calcium carbide, phosphorus, aluminium, &c., some of which consumed up to 10,000 kw. A distinction should be drawn between furnaces applied for work where electricity was pre-eminently suitable and those in industries where the electrical furnace is still a competitor with fuel furnaces. In many cases plants had been put into operation owing to the difficulty of transport of materials normally produced in other countries, where water power was abundant. It must not be too readily assumed that because the electrical [illegible] furnace had little to fear from any fuel furnace, it was the only type that could make headway in this country. Electricity [illegible] from coal burning was in general more costly than that produced from hydraulic power. The supply of electricity on a [illegible], and at much cheaper prices must receive first consideration in the near future. The number of generating stations must be reduced, but their position must be carefully [illegible] of the fact that the centres of maximum coal output were tending to alter.

The question whether it was more economical to produce gas from the coal at the collieries and transmit it under pressure to

generating stations also deserved consideration. No great decisions on these points of national importance should be taken without a very careful survey of the whole problem. A scheme of electrical linking up of existing generating stations should precede any great changes in the matter of centralisation of electric power supply.

After summarising the advantages to be gained by linking-up systems, and discussing the best means of co-operation under a control board, Mr. Allen referred to the question of quality of coal. There was much waste of transport in the conveyance of hundreds of thousands of tons of useless material, which was incombustible. In the Midlands the overall cost of incombustible matter contained in coal to the user must average £1 per ton. It was useless to quote figures for lbs. of coal per unit generated unless the heat-value of the coal used was specified. There would be a great saving in connection with fuel if a standard specification for coal could be agreed upon.

In conclusion, Mr. Allen referred to the desirability of fuller utilisation of the engineer's services on national problems, mentioning the bulletin issued by the United States Consulting Board, which deals with the submarine and kindred problems. It was interesting to notice that the Board that issued the bulletin consisted mainly of electrical engineers. The governing bodies in the United States realised the importance of encouraging serious thought on such problems, and providing opportunities for men to find opportunity of serving their country in some specific line of service. In this country it was likewise most desirable to secure the co-operation of all the available talent in dealing with such problems, and, in particular, to mobilise those in the electrical industry in the service of the nation.

TANNING BY ELECTRICITY.*

A process for tanning and impregnating materials according to the principles of electro-osmosis is patented by Botho Schwerin, of Frankfort-on-the-Main, Germany (assigned to Elektro-Osmose Aktiengesellschaft of Berlin, Germany). As applied to tanning hide with tannin, the process is as follows: (The hide is assumed to have been plumbed with lime.) In Fig. 1 A [illegible] vessel, subdivided into four compartments by [illegible] 5 and 6. The middle compartment is further sub-divided into compartments 2 and 3 by the hide 7 which is stretched on a frame either directly or with use of a support. Behind the diaphragms are arranged

FIG. 1.—[illegible] APPARATUS.

perforated poles 8 and 9, [illegible] with the diaphragms. The latter may consist of [illegible] parchment paper or [illegible]. The cathode chamber 1 and the anode chamber 4, are filled with water, [illegible] [illegible] sulphuric [illegible] [illegible]

The [illegible] the cathode. [illegible]

* From [illegible]

cathodic diaphragm. On the other hand, the negative ions which prevent or limit the migration of the tannin migrate first through the hide and then into the anode chamber through the indifferent diaphragm. Proportionally to this progressive purification of the tannin liquor, the solution of the tannin migrates through the hide and appears in the middle chamber 3, whence the solution is withdrawn. After it has been replenished it can be used again. This has the advantage that the longer the tanning liquor is used the purer it is. The anodic diaphragm must have such a potential that the actual ions can migrate through it, while the tannin cannot. If pure tannic acid solution, which contains no ions that can hinder osmosis, is used from the beginning, the hide need not be stretched in the middle chamber, but merely suspended therein. Circulation of the tanning liquor by stirring is then permissible.

If an impure tanning liquor contains acid residues, the osmosis of the tannin solution will not occur until the acid residues have passed the hide in order to be separated by the anodic diaphragm. If now by stirring the acid residues are again brought around to the cathode side, the migration of the tannin solution and therefore the tanning will be more or less delayed. So also basic residues which are brought by stirring to the anode side of the hide, act to diminish the electric charge of the hide by the back-migration, and this is obviously accompanied by a delay of the migration of the tannin. In impure tannin solutions, therefore, the hide must be stretched. (1,229,150, June 5, 1917.)

ELECTRICAL CONTRACTORS' GUARANTEE SCHEME.

We are informed that the Guarantee of Work Scheme of the Electrical Contractors' Association, as set out in the Articles of N.E.C.T.A. (Ltd.), a company formed by the Association for the express purpose of putting the scheme into practice, is at length an accomplished fact. The facts are fully set out in the December issue of the "Electrical Contractor." Presented to the Council first in 1912, the proposals now finally adopted have been subjected to more discussion and have triumphed over more widespread opposition than anything else the Association has taken in hand. Twice previously the goal appeared to have been reached and a date fixed for putting the scheme into operation only for the whole matter to go into the melting pot again, first at the instance of the Board of Trade, which found the new proposals inconsistent with the Charter of Incorporation of the E.C.A., and so necessitated the formation of N.E.C.T.A. (Ltd.), and later by the renewed opposition of certain [illegible]

[illegible]

guarantee with its purse.

[illegible]

[illegible] will

[illegible]

The Electrician.

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ON THE GIVING OF PROXIES.

It will be remembered that in May last the Institution of Electrical Engineers took the unusual step of adopting proxy voting, so that all its members might readily take part in special decisions reached at general meetings of the Institution. At the time this step was taken some opposition was evident, and we expressed the view in The Electrician that the change would not necessarily be beneficial. In the case of limited companies this method of voting is obviously desirable, and as a rule the point at issue is clearly defined. It may be that an important financial decision is to be reached, such as the sale of the business, or the raising of further capital to the prejudice of existing shareholders; or it may be that the state of affairs in the opinion of many shareholders is very unsatisfactory and that a committee of inquiry is desired. In such cases the use of proxies is a distinct advantage, so that the interests of shareholders at a distance may be protected.

In scientific societies such acute questions seldom arise. Matters of policy must inevitably be left in the hands of the Council, and, generally speaking, a proposed change in the Articles of Association is almost the only matter that may arise on which the membership at large will desire to express an opinion. In the case of the Institution of Electrical Engineers the only instances of recent years in which the desirability of proxies was evidently felt was when it was proposed to expel enemy members and when a new class of membership was to be formed.

We are moved to make these remarks on account of a special general meeting held last week by the Institution of Electrical Engineers. It was a disciplinary meeting, private in character, and, therefore, we are not free to give any account of the proceedings. Suffice it to say that proxy forms were sent out by the Council, and members were requested to return these, placing their votes in certain hands. No statement was issued at that time by either the Council or by the member whose conduct was in question as to the merits for or against the proposed action, and thus it happened that many members sent in their proxy forms without knowing anything whatever about the case. Now, a few moments' consideration would have shown the members that in executing their proxies as requested they were giving their votes to one who had already judged the case. Later on a statement was issued by the member in question and then we discovered that some of the members who had executed their proxies came to the conclusion that they had acted somewhat hastily and inadvisedly. The net result of the proxies, if used, was to render the deliberations of the meeting, which we are glad to state was very representative, quite ineffective, since the proxies rendered a decision in favour of the Council's view inevitable. We are glad that during the course of the meeting the [illegible] of such a position became clear on all sides.

It must be remembered, however, that any person is free to canvass for proxies to further his own views, and it is thus clear that the Council having adopted a particular view themselves must inevitably ask for proxies in order to counteract any proxies obtained against this view. Hence it appears that the evil, once started, cannot well be stopped.

The moral of the incident is that members should not execute proxy forms without a due sense of their responsibility. To hand over one's conscience in judging questions of right and wrong into the care of another member is not a procedure to be adopted in cases of this kind. Any such shifting of personal responsibility may, in our opinion, react seriously upon the Institution itself, and we feel that where the conduct of a member is in question, proxies should be entirely ruled out. We fear that as matters stand at present this is not legally practicable, and that when a special general meeting is called any member is free to obtain proxies. It might, therefore, be necessary to alter the Articles of Association once more, and although this involves a certain amount of formality and trouble, we certainly feel that it should be done if the interests of individual members are to be safeguarded.

REVIEWS.

Preliminary Mathematics. By Prof. F. E. Austin, B.S., E.E. (London: E. & F. Spon, Ltd.) Pp. iv. + 169. 5s.

This book has been written for the use of those pupils whose mathematical training has been limited to the study of arithmetic, and it is of the nature of a connecting link between that subject and algebra. The author has carefully selected the subject matter so that the work will be found particularly useful to the pupils of the eighth grade in American schools and of the "Junior High School."

The book is divided into two Parts, of which Part I. is subdivided into 15 lessons, dealing with such subjects as notation, Roman figures, algebraic symbols, mathematical processes (÷), decimals, negative quantities, roots, proportion and logarithms.

Part II. is particularly useful to the rather more advanced student who wishes to pursue the study of algebra somewhat further, for the purpose, for example, of sitting for the American College Entrance Examinations. This Part contains a further eight lessons dealing with such subjects as quadratic equations, progressions and clock problems.

A feature of the book is the considerable number of typical examples fully worked out for the guidance of the student, many of which are prepared to show the practical application of the theory under discussion, and the problems which follow, are provided in Part II. with answers in order to assist the private student. The book concludes with a number of papers recently set in algebra at the various American College Entrance Examinations with complete solutions to the questions set.

Useful tables of interest, and of weights and measures and a comprehensive index of the contents, complete a book which should prove useful to those students for whom it has been prepared.

B. W. C.

Actions Physiologiques et Dangers des Courants Electriques By J. Rodet. (Paris: Gauthier-Villars et Cie.) Pp. 88. 3fr. 25c.

Of the six chapters into which M. Rodet has divided his book, only one relates to the physiological actions of currents of electricity, and in this is provided a most excellent summary of the chief work performed by physiologists in this connection. The bulk of the remainder of the volume contains a description of the dangers that may arise in connection with the use of electricity, and of the methods that may be adopted in order to avoid or prevent accidents. One chapter M. Rodet reserves for a description of a number of accidents recorded as having occurred in various parts of the world. The statistical analysis that accompanies this description should, as the author believes, prove interesting and useful both to those who employ and those who use electricity. A very practical chapter is that in which the various methods that have been suggested and used on behalf of victims of accidents are described.

M. Rodet is an author of considerable experience, and the writing here bears witness to the fact. He has set out the results of his researches, which must have been wide, very clearly and well, and has produced a most readable book full of information certain to prove most helpful. C. P.

Elementary Principles of Wireless Telegraphy. By R. D. BANGAY. (London: The Wireless Press, Ltd.) Pp. viii.+241. Part II. 2s.

The first edition of this book was reviewed in THE ELECTRICIAN of July 2, 1915, so that we need not say very much on the occasion of the second edition, which has now been issued. This edition is divided into two parts to make it more convenient for the student. Part I., in addition to the matter published in the first edition, contains further information regarding receivers and aerials, and in Part II. the component parts of a transmitter are explained separately, along with the theory of the conditions of resonance under which they can most effectively be combined, and to which each part should be adjusted to form an efficient transmitter.

CORRESPONDENCE.

D. S. AND S.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to the article in the current issue of THE ELECTRICIAN, entitled "D. S. and S.," it will be generally agreed that it has now become a matter of urgency for something definite and adequate to be done for disabled soldiers and sailors; and while the electrical industry in general and the electricity supply authorities in particular cannot do more at the most than touch the fringe of the problem, that is no reason why they should not set an example to other industries and authorities by doing what they can. The first essential to success in any scheme for the employment of these disabled men is a real desire to do something for them as a slight return for what they have done for the country. If one is unfortunate in the particular men selected for experiment, there is a tendency to jump to a rash conclusion as to the general unsuitability of disabled men for the particular class of work concerned.

In the electricity department of the Glasgow Corporation we have experimented to a considerable extent with ex-army men whose disability is the want of an arm or a leg. These men have been put into the meter repairing workshop, and the results have been most satisfactory. Five one-legged men, after a short period of training under an experienced tradesman, have successfully acquired sufficient skill to repair and overhaul several types of mercury ampere-hour meters. In civil life, prior to entering the army, these men were engaged in such work as coal mining, calico printing, railway shunting and other work of an unskilled nature. The essential requirement on the part of the men to fit them for work of a light semi-skilled nature is willingness to learn. The men we have in our employment have fulfilled this requirement in a most encouraging manner, and the physical disability has been largely overcome by general alertness and anxiety on the part of the men to justify themselves.

Our experience with one-armed men has been no less hopeful. We have engaged several of these men, mainly for light labouring work, taking meters to and from consumers' premises, and cleaning and re-enamelling meter cases.

The motive in experimenting with these men was to see what could be done to help them; but in the sequel we have found that they have responded so readily to our efforts on their behalf that their continued employment has become quite a sound commercial proposition.

I shall be glad to furnish particulars of our method of training to any one who is interested.—I am, &c.,

Corporation Electricity Dept., W. W. L[illegible]
Glasgow, Nov. 28.

I.E.E. DISCUSSION ON THE METRIC SYSTEM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the note published in your issue of Nov. 23 under the above heading reference is made to the lecture I had the honour of delivering before the members of the Institution of Civil Engineers and kindred institutions in March last.

My lecture was subsequently reproduced in pamphlet form, of which I enclose a copy and, in the event of any of your readers being particularly interested in the approaching I.E.E. discussion, I should be glad to supply copies as far as my stock permits on hearing from them.

The inclusion of this subject in the I.E.E. syllabus for December 13th is welcome, as affording a further opportunity for its complete ventilation at a time when it is receiving considerable attention. I venture to hope those participating in the debate will devote their attention to the suggestion of ways and means of overcoming such difficulties as are incidental to any change rather than to criticisms of the destructive order which would merely postpone—and therefore render still more difficult—our inevitable adoption of this overdue reform.—I am, &c.,

Hale, Nov. 24. HARRY ALLCOCK, M.I.E.E.

P.S.—In regard to Mr. Silver's letter in the same issue of your journal, I would like to say that the adoption of the word "mil" by the Joint Committee on decimal coinage to signify one thousandth part of the £ sterling is due to the difficulty of finding an alternative expression to convey that meaning. Mr. Silver's suggestion of the word "kil" is hardly suitable, as it implies a thousand times instead of a thousandth part.

DECIMAL COINAGE AND METRIC SYSTEM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to Mr. Silver, permit me to point out that the Greek work "Xilioi" has already been appropriated for the expression of "thousand fold," as in kilogram, kilowatt, while the Latin word has been used for "thousand part," as in millimetre, millivolt. It might have been better to use some old word, such as "stiver" or "groat" for the new farthing, but let us remember the French proverb "Le mieux est l'ennemi du bien," for the advocacy of rival detail means procrastination and the spectacle of unanimity between the three bodies mentioned is too valuable to disturb when there is a chance of our getting a decimal coinage within a reasonable period.—I am, &c.,

London, Nov. 26. EDWARD C. BARTON.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: My brother, Second-Lieut. E. K. Eason, of Eason & Sons, Dublin, has been using the suggested decimalised coinage in some of his work, and suggested the use of the word "mite" as the one thousandth part of a £1. This word seems very reasonable, as it corresponds to an existing coin, and has the "mi" in it. I should think [illegible] would [illegible] the use of "mil" as it is so universally used [illegible].—I am, &c.,

Dublin, Dec. 4. ALEC B. EASON.

BRITISH METHODS IN FOREIGN TRADE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: A letter from [illegible] recently appeared under the above heading in some of the electrical papers from "[illegible]," and I crave leave to give a small example of how things should not be done.

In September, 1916, [illegible] to India, I personally gave an order to a very well-known London firm for an electric heater, [illegible] 22s. I think. I was [illegible] these were in stock at the moment. [illegible] a few months ago, and the heater arrived in September, 1917. I used it at breakfast [illegible] before it burnt out, [illegible] within a small margin. But the point is that it [illegible]. The elements are placed at the [illegible]

[illegible] so that no ingenuity could prevail on the bread to toast down the middle. The engineer of the Simla supply, whose electric fires and water heaters are ahead of most types I have met, rewired the device for me in a sensible manner, and now it makes good toast.

Simla, Oct. 31. J. W. MEARES.

COMPARATIVE TESTS OF COAL, KEROSENE AND ELECTRICITY FOR COOKING.*

BY B. L. STEELE.

The efficiency tests of gas, kerosene, gasolene, and alcohol burners and of electric heating appliances have been made each year by the girls in a course at the State College of Washington, and have been checked by the writer and his assistants. The tests on coal ranges were made on the two Monarch ranges in the home economics department and on the ranges in the homes of students, &c. The cooking cost data were obtained at the Home Economics Practice Cottage.

Table I. gives the value in calories, or the heat equivalent, of 5 cents' worth of each of the various "fuels" at the prices prevailing in Pullman, Wash., in December, 1916:

Table I.

Fuel.	Calories.
Coal (Rock Springs) at $10 per ton	32,250,000
Kerosene at 20 cents per gallon	8,550,000
Gasolene at 25 cents per gallon	6,130,000
Alcohol at 75 cents per gallon ..	1,340,000
Electricity at 3·85 cents per kw.-hour	1,116,000

Table II. gives the average efficiencies of the various kinds of cooking equipment. In determining the maximum efficiency of the coal range the entire top was covered with large vessels of water —*e.g.*, wash boilers or 5 gallon gasolene cans, the over being similarly used. The fire was not lighted until the initial water temperature had been taken; and usually 2 lb. of kindling and 1½ lb. of coal were completely burned before the record of the final maximum temperature was made. As the coal range is used for cooking in the average home, not more than one-fourth of the available space is utilised at any one time and cooking operations are being carried on less than one-half of the time, during which the coal is burning. On this basis the average "cooking" efficiency of the coal range does not exceed 2 per cent.

Table II.

Kind of cooking equipment.	Efficiency. Per cent.
Coal range (entire space utilised)	18
Coal range, estimated home cooking (about)	2
Flame contact burners (kerosene, &c.)	28
Electric heaters, surface	15 to 65
Electric heaters, enclosed	70
Electric heaters, immersion	90

The efficiencies of the flame contact appliances, which included standard kerosene and gasolene blue flame burners, alcohol lamp for chafing dishes, and gas burners, varied from approximately 20 per cent. to 35 per cent.

Nearly every kind of electric heating appliance was used and under widely varying conditions. Room temperature, existence of air currents from open windows, material and condition of surface of utensil used, wattage of heater, relative size of heater and utensil, and quantity of water heated were all found to affect the efficiencies very considerably, particularly those of the surface and immersion types. Accidental errors should not give rise to a variation in efficiency greater than 1 per cent.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

[illegible]

* Abstract of an article in The Electrical News.

15,041 GREEN, H. Electric signalling. (9/11/16.) 110,424.
17,045 RAWLING, M. J., FARTHING, J. H., & WINSTANLEY, F. Electric heating apparatus (2/11/16.) 110,438.
18,054 PAGANINI, E. Railway signalling system. (23/12/15.) 102,953.

1917 SPECIFICATIONS.

[illegible] ZEITLIN, J. Electric connection devices for use in internal combustion engines (17/1/17.) 110,255.
1,062 HOWARD, W. J., & REYROLLE & CO. Switching apparatus for electric transformers. (22/1/17.) 110,259.
1,575 VILLIERS ENGINEERING CO., FUNCK, G., & FARRER, F. H. Contact breaker devices for the ignition mechanism of internal combustion engines. (31/1/17.) 110,266.
1,764 MOSSAY, P. A. H. Dynamo-electric machines. (3/2/17.) 110,269.
6,309 IGRANIC ELECTRIC CO. (Cutler-Hammer Mfg. Co.) Electric motor control system. (3/5/17.) 110,311.
9,267 CRABB, V. Dynamo-electric generators. (28/6/17.) 110,329.
10,575 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. (Westinghouse Electric & Mfg. Co.) Circuit interrupting devices. (23/7/17.) 110,332.

Comprises a circuit breaker and a trip coil therefor with a relay operatively connected to the circuit to be protected and an electromagnetic switch controlled by the relay for connecting the trip coil in series with the operative winding of said relay, and an inductive resistance connected across the terminals of the electromagnetic switch operating coil for the purpose of maintaining the potential across said coil substantially constant after the relay has operated.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

October 31, 1917.

15,849 FLETCHER. Electric torch case.
15,888 LANGUEPEN. Electrodes for arc welding.
15,883 GOULD & STAMP. Gas burners and electric lights.
15,897 KOHLMEYER. Storage batteries.
15,901 BROWN. Holder for electric lamp shades and lamps. (Divided application on 15,357/16.) 108,477.
10,113 LEVIN, I. H. Electrodes for use in electrolytic gas generator. (20/12/15.)

November 1, 1917.

15,927 COMPARE & PIZZI. Electric gas lighter.
15,930 BRYAN. Sparking plugs.

November 2, 1917.

15,970 KEELEY. Electric plug.
15,978 ELECTROMOTORS (LTD.), GREENHALGH & LONGBOTTOM. Dynamo-electric machinery.
15,992 BUTLER. Incandescent electric lamps.
16,008 TACCHIO. Telephone control systems.
16,017 BELLAVITE. Heating electrode.
16,021 WESTERN ELECTRIC CO. Sound detectors.
16,024 BROWN. Telephone transmitters.

November 3, 1917.

16,033 LANCASHIRE DYNAMO & MOTOR CO. & WHITMORE. Friction clutches, &c.
16,039 FARRELL & WARD. Means for completing electric circuit for alarm clocks.
16,053 FALKIRK IRON CO. & NOBBS. Electrical resistance elements.
16,054 FALKIRK IRON CO. & NOBBS. Electrical heater.
16,072 BARFIELD & WILD. Indicating condition of magnetisable steel, iron, &c., during heat treatment.

November 5, 1917.

16,103 SPENCER. Insulator and binder for telegraph, &c., wires.
16,116 BOWREN. Magneto-electric machines.
16,120 BROWN, BOVERI ET CIE. Maintaining constant voltage in lighting circuits. (11/11/16, Germany.)
16,121 BROWN, BOVERI ET CIE. Elastic couplings for eccentric shafts. (10/11/16.)
16,122 BROWN, BOVERI ET CIE. Constitution of the magnetic circuit in electric ignition apparatus for internal combustion engines. (12/1/17, Germany.)
16,136 PRITCHETT & GOLD & E. P. STORAGE CO. Accumulator boxes.
16,145 PRENTICE. Electric furnaces.
16,154 ETABLISSEMENTS DE DISU-BOUTON. Vats for accumulators, &c. (11/1/17 France.)

November 6, 1917.

16,172 WOODMAN. Press button flash lamps.
16,179 HAMILTON. Incandescent lamps.
16,184 PHILLIPS (ROGERS). Elevated railways, tramways, &c.
16,198 WESTINGHOUSE ELECTRIC & MFG. CO. Geared turbine installations. (11/12/16, U.S.)
16,202 HUNT. Electric switches.

VOLUNTEER NOTICES.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Oxford-street, W. 1.

Orders for the Week.

Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.

Officer for the Week.—Sec.-Lieut. P. Bowden.

Next for Duty.—Sec.-Lieut. F. Gaywood.

Extract from "London Gazette."—Temp. Lieut. A. J. N. Gerard resigns his Commission (Aug. 13).

Promotion.—Corporal G. T. Gillespy to be Sergeant, Nov. 26, 1917.

Drills: Week ending Sunday, Dec. 16, 1917.

Monday.—No. 3 Company, Left Half, Recruits, Signalling, 6.30.
Tuesday.—Physical Drill and Bayonet Training, 7.30.
Wednesday.—No. 1 Company, 6.30.
Thursday.—No. 2 Company, 6.0. Signalling, Ambulance, 6.30.
Friday.—No. 3 Company, Right Half, Recruits, 6.30.
Sunday.—Commandant's Parade for Instruction in Camp Arrangements at Esher. Parade Waterloo Station, opposite No. 10 platform, 8.30 a.m. Uniform. Haversack, waterbottle and mug. Midday rations to be carried. Compulsory for men in sections A, B and C.
Musketry.—Belvedere-road, Tuesday, Wednesday and Thursday, 5.30 to 7.0.

NOTE.—The Medical Officer will attend for examination of recruits, &c., on Thursday at 6.30.

Unless otherwise indicated, all drills will take place at headquarters.

COMMERCIAL & INDUSTRIAL SECTION.

Government Control of Trade.

At the meeting of the British Engineers' Association last week a resolution was passed objecting to the continuation of Government control of imports and exports, as proposed [illegible] the Imports and Exports (Temporary Control) Bill.

* * *

Double Income Tax Within the Empire.

At the annual general meeting of the Association to Protest against the Duplication of Income Tax within the Empire, the annual report was adopted and a resolution of protest against the continuance of the double tax was passed.

The chairman of the association, Mr. F. Dutton, [illegible] although they had made great progress towards the ultimate attainment of their aims, they were blocked from further progress by the [illegible] passed at the Imperial Conference to the effect that the matter must be taken in hand immediately after the war. The Chancellor of the Exchequer pleaded his inability, while admitting the grievance, to remedy it by a further remission during the war, although he knew full well that it was the existence and increasing tendency of what they called the double war taxation caused by the war which aggravated the injustice to an almost unbearable degree—surely a somewhat illogical position.

Although New Zealand was not shy as to increasing the rate of income taxation, their Parliament had been the first of the Legislatures within the Empire to embody in an Act of Parliament [illegible] which provided that income not derived in New Zealand and taxed elsewhere within the Empire should not be taxed there except to the extent of the difference between rate in force in New Zealand and the rate of tax paid elsewhere.

* * *

Gas Traction.

The Local Government Board have appointed a Committee to consider and report upon the employment of gas in substitution for petrol and petroleum products as a [illegible] power, especially in motor vehicles, and the action, if any, which should be taken by H.M. Government to encourage and [illegible] the use of gas for this purpose.

The Committee is composed as follows:—

Sir Boverton Redwood, Bart., Major A. M. Cooper-Key, C.B., Sir Evan O. Jones, Bart., Mr. H. H. Law, C.B., M.Inst.C.E., Sir Arthur Churchman, Bart., Mr. W. Doig Gibb, Dr. Chas. C. Carpenter, Mr. Edward S. Shrapnell-Smith, Mr. James Ollis, Lieut.-Col. R. K. Bagnall-Wild, R.E., Mr. F. W. Goodenough, Ald. William Kay, Mr. Geo. W. Watson and Mr. W. Worby Beaumont, M.Inst.C.E.

Mr. Shrapnell Smith has consented to act as secretary, and communications should be addressed to him at 8, Northumberland-avenue, W.C. 2.

* * *

Japanese Iron Industry.

Supplementary regulations, which [illegible] Imperial Ordinances Nos. 125 and 126 dated [illegible] the new law having for its object the encouragement of the iron industry in Japan, [illegible]

[illegible]

Indian Imports.

Total foreign sea-borne imports (excluding treasure) for the year ended March, were valued at R.1,602,357,000 (compared with R.1,381,693,000 in previous year).

In volume, however, there was a decrease, and by recalculating the 1916-17 imports at the prices prevailing in 1915-16, the decrease was equal to R.144,922,000. Amongst the 1916-17 imports were machinery and belting, R.60,142,000 (R.52,571,000); iron and steel and manufactures of same, R.88,681,000 (R.91,852,000); metals, other than iron and steel, and manufactures of same, R.18,299,000 (R.19,591,000). Iron and steel prior to the war came chiefly from Germany and Belgium, and there has been a considerable increase of such imports from the United States. Motorcars from the United States increased in number from 2,136 (in 1915-16) to 4,169. Total imports from Japan have increased by 266 per cent. compared with pre-war figures. Total imports from the United States were valued at £7,304,000 (compared with £5,247,000 in 1915-16) and included instruments and apparatus £135,000 (against £79,000 in 1915-16); iron and steel, £1,628,000 (£1,600,000); machinery and millwork, £279,000 (£191,000); hardware, £392,000 (£292,000); motor cars and cycles, £973,000 (£391,000); and railway plant and rolling stock, £66,000 (£61,000).

* * * *

Trade Marks in Chili.

To emphasise the importance of securing registration of trade marks in the countries where the goods are sold, the "Board of Trade Journal" gives the following additional instances of the difficulties which arise when registration is not secured:

A British firm of pottery manufacturers supplied wares to the Chilian market through a firm in that country, the agreement being that so long as the Chilian firm continued to handle the goods, the United Kingdom firm would not sell to any other house in the Republic. The goods in question were marked with a trade name, and the Chilian firm registered the mark in their own name and as their own property. In the course of time the Chilian firm was put on the Statutory List, and the United Kingdom firm had to arrange for other representation. In the end, the United Kingdom firm had to adopt a new trade mark.

A few years ago another United Kingdom firm omitted to register in Chili a mark which was well known. This mark was registered by a Chilian manufacturer, with the result that before the United Kingdom firm could sell goods under the trade mark in that country, they were obliged to wait until the expiration of the term for which the mark was registered, and then to take proceedings to prevent a renewal of the registration. No person should, therefore, allow his mark to be registered by his agent in his own name.

* * * *

Commercial Relations with Brazil.

At the suggestion of the [illegible] of the United States, France and England, [illegible] will be established in all [illegible] of Brazil, with the object of developing commercial relations [illegible] by a [illegible] various markets.

* * * *

Prohibited and Restricted Exports.

On Nov. 27 the Privy Council [illegible] additions and alterations to the list of prohibited [illegible] exports.

[illegible]

ELECTRICITY SUPPLY.

EXTENSIONS.

Leicester.—The Council decided last week to apply for a provisional order to authorise the acquisition of land for their proposed new electricity works.

The Council also approved of the estimates of the proposed expenditure on the scheme, the total of which was put at £285,000.

Liverpool.—The L. G. Board has sanctioned a loan of £52,000 for laying electric supply mains in the Aintree and North-end district.

Sunderland.—At a special meeting last week the Electricity Committee considered a request by the County of Durham Electrical Power Distribution Co. to permit the company to supply current in that part of the new premises at Pallion upon which the Egis Ship yard was being erected, and which portion was within the Corporation's authorised area of electricity supply.

After giving the matter careful consideration, the committee unanimously decided to recommend the Council to withhold their consent.

The committee also considered a report by the electrical engineer (Mr. Blackman) as to a proposal made to him by the Newcastle-upon-Tyne Electric Supply Co. for the interchange of electrical energy. The committee decided that they were not prepared to fall in with the proposal.

It was also reported that statements were being widely circulated to the effect that the Corporation electricity undertaking was not in a position, owing to shortage of plant, to meet the demands for the supply of electrical energy for power. It was, however, stated that these statements were unwarranted, as the undertaking is satisfactorily meeting all power demands, and the Corporation are prepared to negotiate for the supply of power to any additional consumers requiring it.

Wallasey.—The electrical engineer (Mr. J. A. Crowther) has prepared a report upon a proposed scheme for the supply of electrical energy in bulk to Hoylake and West Kirby.

The scheme is part of a larger scheme suggested by the Board of Trade for the purpose of economy in coal. Mr. Crowther's report has been adopted by the Electricity Committee, and the matter will come before the Council this week.

GENERAL.

Aberdeen.—The Electricity Committee has instructed the Town Clerk to apply to the Board of Trade for sanction to raise the price of electricity on account of the increased price of coal, &c.

Birmingham.—The Electric Supply Committee received 266 applications for the position of secretary to the committee. This number was reduced to 16, and a sub-committee has been asked to select three from which the final choice will be made.

Board of Trade Electric Power Committee.—The Municipal Conference on Electricity Supply recently appointed Councillor W. A. Hill, Mr. Leslie Gordon (town clerk of Hammersmith) and Mr. L. L. Robinson (borough electrical engineer of Hackney) to give evidence before this Committee, and that Mr. Robinson has already given his evidence on behalf of municipal undertakings.

Bristol.—The question of the lighting of the streets has again been before the Sanitary Authority Committee owing to the committee's recommendation being referred back. On Nov. 1 the Committee resolved as follows:—

"(1) To light all arc and half watt electric lamps; (2) to light all incandescent electric lamps; (3) to have the bottom ledges of all electric lamps painted with one coat of white paint; and (4) to have light blue substituted for the present dark colours on the lower part of all gas lamps."

The Council, however, instructed the committee not to alter the lighting of the incandescent street lamps in any manner that will necessitate the whole of the incandescent electric lighting of the city, domestic and public, being cut off upon receipt of air raid warnings. The committee [illegible] carrying out their proposals. There are 698 arc and half-watt lamps, all being in use except about 104, and these will be lighted about the end of the present week. There are [illegible] electric incandescent lamps, 629 have been in use throughout the year and 944 were not in use. If brought into use the latter could not be extinguished independently without at the same time cutting off all private incandescent lighting, and this also applied to the 629 lamps in use. [illegible] and the City Engineer were agreed that [illegible] the extinction at the same time of all incandescent electric lighting in private and public buildings.

[illegible] recommended that [illegible] Manchester and other towns were [illegible] that all electric supplies would be cut off. [illegible] alternative lighting and the [illegible] public buildings. [illegible] It had been arranged that the power supplies would first be cut off and then the lighting. The two alternatives before the Council were (1) to exclude the whole of the incandescent electric lighting and to use the arc and half-watt lamps, (2) to include the whole of the incandescent as well as the arc and half-watt lamps, and also accepting liability for the extinction of all incandescent lighting in case of a raid.

After discussion, the committee recommended the adoption of the second alternative.

Colne (Lancs.).—The Electricity Committee has appointed a sub-committee to consider and report upon the question of increasing the prices of electric current for power and light.

Croydon.—Councillor Peet has been elected chairman and Councillor Gough vice-chairman of the Lighting and Electricity Committee.

Derby.—The Corporation are in difficulties in connection with the supply of electric current.

It was necessary to suspend the tramcar service for several hours on Monday of last week, and the indoor lighting was reduced. The Electric Committee have now enforced their previous injunction to consumers to exercise economy between 3.30 and 6.30 p.m. by an intimation that unless they assist in this way it may become necessary to restrict not only the tram service, but all supplies to shops and dwelling-houses. An increase of 10 per cent. in the charges for electricity, which is to come into force next month, may be expected to have some slight effect in decreasing the consumption.

The present position is mainly due to the failure of the Committee to secure the delivery of additional plant which has been on order for several months, and another factor is the inferior quality of the coal available.

Exeter.—The Electricity Committee, acting on the recommendation of the Controller of Coal Mines, has decided to apply to the Board of Trade for sanction to disconnect classes of non-essential consumers in cases of urgent necessity, so as to be able to supply essential users.

The Committee has asked the Council for authority to revise the charges for electric current if an advance in the price of coal or other special circumstances make it necessary.

Increased Charges for Electrical Energy.—The charges for current are being increased at the following places:—

Nelson Electricity Committee has decided to increase the price of current by ½d. per unit for lighting and ¼d. for power.

Leeds Electricity Committee recommend a further increase of 10 per cent., making 20 per cent. in all over pre-war rates.

Barnes Council has adopted the following charges for current, less the present discounts:—For lighting 4½d. per unit, power and heating 1¾d. The alternative rateable value tariff is to be 1½d. and 1d. instead of 1d and ½d.

Pontypridd Electricity and Tramways Committee has decided to increase the charges for current by 10 per cent.

At Stirling the charge for current for private lighting has been increased by ½d. to 5¾d. per unit.

The City of London Electric Lighting Co. announces that the war percentages of all its charges for electricity supplied after the commencement of the quarter ending March, 1918, will be 30 per cent. for power and 20 per cent. for lighting, heating, &c.

Islington (London).—Ald. Vorley has been re-elected Chairman of the Lighting Committee and Councillor E. T. Lindow has been appointed Vice-Chairman of the Committee.

Municipal Industrial Council.—Marylebone Borough Council adopted last evening a recommendation of the General Purposes Committee to agree to the Metropolitan Boroughs Standing Joint Committee being authorised to take steps for the constitution of a Joint Standing Industrial Council, representative of the Metropolitan Councils and their workmen.

Mytholmroyd.—The Urban Council has decided to take a supply of electricity from Halifax Corporation, and consumers at Mytholmroyd will obtain current on the same terms as those in Halifax plus 5 per cent. The Council will support the application of Halifax for a provisional order.

Nottingham.—On Friday last silver rose bowls were presented to Mr. H. Talbot (city electrical engineer) and Mr. Arthur Brown (city engineer) by Mr. R. H. Swain, chairman of the Electricity Committee, on behalf of Sir John Turney, the former chairman of the Committee.

Mr. Talbot has rendered valuable services to the electricity department during the 25 years Sir John Turney has been connected with it, and Mr. Brown has occupied the position of city engineer for 37 years.

A recent award of the Committee on Production gives an increase of wages to the employés of the electricity supply, gas, tramways and other municipal departments, which amount to about £20,000 per annum. Male employés 18 years of age and upwards receive such further amount as shall make their advance 12s. per week, payable at the rate of 2s. per day or shift for each day or shift worked. Female employés 18 years of age and upwards receive an advance of 3s. per week, and employés under 18 years of age receive 1s. 6d. per week on the war wage advance.

Portable Plants for Military Dressing Stations.—It is stated that portable electric light plants are to be provided in the Canadian battle areas by the Canadian Red Cross for use in advanced dressing stations, and candles and oil lamps now in use will be replaced by electric lamps.

Reading.—A request to the Council by the Reading Electric Supply Co. for permission to increase the charge for electric current by 1d. per unit has been referred to the Lighting Committee.

Remuneration of Station Engineers.—In a circular issued by the Association of Electrical Station Engineers, electric supply undertakers are asked to consider certain resolutions passed at a recent conference of power station engineers represented by the association relating to—

(*a*) The abnormal increase in the cost of living; (*b*) requesting that a bonus or war wage of 15s. per week be granted to engineering assistants in the grades enumerated; (*c*) the anomalous remuneration of engineering assistants during the past three years due to the absence of uniformity of treatment; (*d*) that the remuneration of such assistants has at no time been commensurate with the qualifications demanded; (*e*) requesting that a 15 per cent. increase of the pre-war salary attaching to the offices of the engineering assistants of the before-mentioned grades be granted to all such assistants; and (*f*) that the normal shift shall consist of eight hours, and that a normal shift week shall consist of six eight-hour shifts.

A circular letter has also been sent out by the hon. secretary of the Incorporated Municipal Electrical Association, drawing attention to (I.) the position of electrical undertakers as regards the difficulty of retaining the services of their technical assistants; (II.) the tendency in the past to underpay engineering assistants; and (III.) recommending as a first step that the bonus awarded by the Committee on Production should be paid (where this has not already been paid) to all members of the staff, and suggesting that the general question of the remuneration of the technical staff should receive the earliest possible attention.

Worcester.—Owing to the resignation of Mr. Baynham, the senior charge engineer at the electricity works, the Electricity Committee recently advertised for two charge engineers at a commencing salary of 50s. per week, plus 5s. war bonus, but the electrical engineer (Mr. Shaw) reported that none of the applications received were satisfactory.

On the chairman's authority, Mr. Shaw tried to get applicants at the increased salary of 55s. per week and 10s. [illegible]

The Committee then considered the question of salaries and war bonuses, and decided to grant increases to the following members of the staff: Mr. R. Smith, chief assistant and mains superintendent; Mr. H. Smith, station superintendent; Mr. [illegible], charge engineer; Mr. Powell, charge engineer; Mr. Hounslow [illegible] war bonus of 10s. per week instead of 2s. 6d. as at present; Mr. [illegible] 5s. per week, Mr. Pacy 5s. per week and Mr. Rigby 5s. per week.

ELECTRIC TRACTION.

Board of Trade Tramway Committee.—Mr. Wardle, replying to a question in the House of Commons on Monday, stated that it was not intended to pay salaries to the members of the Committee recently appointed by the Board of Trade to control the supply of materials, &c., for tramways.

Bradford.—The War Wages Committee recently refused to consider the demand of the tramway employees. The latter have now given 21 days' notice to the Committee on Production that a dispute is pending.

The demands of the employees are [illegible] per week on pre-war rates (the same to be merged [illegible] instead of bonus), double time for all time worked on Sundays [illegible] holidays, and equal pay for males and females engaged on the same class of work.

Christmas Tramway Services.—[illegible] Committees have decided [illegible] to suspend the tramway services on Christmas Day.

Maidstone and Hull Committees, on the other hand, have decided to give a limited service on Christmas Day.

Coventry.—[illegible] Mr. [illegible] has been increased [illegible] per annum.

Croydon.—[illegible]

Edinburgh.—[illegible]

Hull.—[illegible] Christmas Day [illegible]

[illegible]

during war-time, but an armature broke down, and the station was now dependent on one large and three small sets. Any further failure within the next few days would involve a temporary reduction of service. Unless the committee took considerable risk, the provision of additional power should not be long delayed. A spare armature should be purchased immediately, and Messrs. Siemens Bros. Dynamo Works had offered to supply one for £1,310, but the Controller of Munitions had refused his sanction. The provision of a third set, which was a preferable course, would cost between £10,000 and £15,000.

Mr. RAINE (deputy chairman) said the position was a very difficult one. He suggested that the situation should be considered at a special meeting, including the question of drawing part of their power from the Electricity Committee. As a tramway undertaking, they had no reserve power, and they ran the risk of a very serious breakdown.

This suggestion was adopted.

TENDERS INVITED AND ACCEPTED.

Cooling Towers.

MANCHESTER Electricity Committee require tenders by 10 a.m., Dec. 12, for the supply and erection of three fan-draught cooling towers at Stuart-street electricity works. Specifications, &c., from Mr. F. E. Hughes, Town Hall, Manchester.

Telephone Service.

ROSARIO (Argentina) Municipality recently invited tenders, which are to be opened on Feb. 23, for the provision of a telephonic service within the district of the municipality.

HAMMERSMITH (LONDON).—The Borough Council have accepted the following tenders:—

British Electric Transformer Co., supply of one 225-k.v.a., 3-phase transformer at £168 and a spare 500-k.v.a. 3-phase transformer at £368.

MANCHESTER.—The Corporation have placed an order with Ferranti Ltd. for the supply of meters for 12 months.

SUNDERLAND.—The Council have accepted the tender of the British Insulated & Helsby Cables (Ltd.) for the supply of e.h.t. box compounds.

TRANSFORMER CONTRACTS.—The following contracts have recently been secured by Messrs. Ferranti Ltd.:—

Annual contract for supply of [illegible] three phase transformers to [illegible] three-phase transformer to [illegible] three phase transformer to [illegible] three phase transformer to Messrs. [illegible] Wilson & [illegible] Messrs. Clayton & Shuttleworth.

APPOINTMENTS VACANT.

Applications are invited for the [illegible] engineer in the electric supply department of [illegible] position. Salary £[illegible] per annum. [illegible] can be obtained from the Secretary, electric Supply department, and applications to be sent to the [illegible] 14, Dale End, Birmingham, by [illegible]

The Education Committee of the [illegible] invite applications for the [illegible] engineering department of the Technical Institute. Commencing salary £2[illegible] a year. [illegible] M.Sc., by Dec. [illegible]

A junior shift engineer [illegible]

A [illegible] shift engineer [illegible]

BUSINESS ITEMS.

[illegible]

Plant Wanted.—[illegible]

Moon Charts.—[illegible]

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

AMAZON TELEGRAPH CO. (Ltd.)—At the meeting last week the Chairman (Mr. C. W. Parish) said he thought the shareholders would agree with him that the improvement as compared with the previous year was quite satisfactory. Business in the Amazonas district had been fairly good. The rubber crop, which amounted to 37,590 tons, was again slightly larger than that of the previous year, there being an increase of a little over 900 tons, and the price of the commodity had remained at a high level, although it would probably have still further increased the company's revenue had there been greater fluctuations. During the year the highest and lowest quotations for fine hard Para rubber were 3s. 7d. and 2s. 8¼d. per pound respectively and for the greater part of the time the price was over 3s., whereas during the previous year it fluctuated between 4s. 1d. and 2s. 4¾d. The traffic receipts of the company amounted to £51,166, against £42,926 for the preceding year, an increase of £8,240. Interest gave them £3,953, or £2,418 more than last year, due to an increase in the investments. Altogether the gross revenue amounted to £72,144, against £61,587 for the previous year, an increase of £10,557, or over 17 per cent. The expenses incurred in maintaining the company's cables came to £14,886, against £14,591 last year, an increase of only £295. The total working expenses amounted to £31,539, against £30,828 for the preceding year, an increase of only £711, or less than 2½ per cent., which was not large considering the general rise in prices which had taken place all over the world. The result, therefore, was that the net revenue amounted to £40,605, compared with £30,759 for the previous year, an increase of £9,846. From the £40,605 the sum of £1,616 had to be deducted for income-tax, £183 for writing down the investments to their market value at June 30 last and £22,925 for the debenture service, which left them with £15,881, and, adding amount brought forward the available balance was £22,687. After placing £8,000 to general reserve account the directors had pleasure in recommending a dividend of 4 per cent. (less tax), leaving £7,187 to be carried forward, compared with £6,806 brought in from the previous year. They had been able, therefore, to add 1 per cent. to the dividend and to carry forward about £400 more. The investments now amounted to £54,313, an increase since last year of £38,839. With regard to the current year the traffic receipts up to the present were nearly £3,000 higher than those for the same period last year. The prospects for this season's rubber crop were believed to be good and a heavier crop of nuts was also expected. A portion of the company's revenue was derived from a service of local deferred messages, which was instituted in July, 1914. Those messages were subject to a delay of not less than 10 nor more than 24 hours, and up to September last year were carried at half rate. The directors, however, were not very satisfied with the result of the experiment, as although that class of traffic at first showed signs of expanding, it ultimately fell away considerably. They decided, therefore, to make a further reduction in the rate, which came into force in October last year, and as a result there was a very satisfactory increase in the number of local deferred words transmitted, the receipts having increased by nearly £3,000 as compared with the previous year. Mr. E. B. Ellis-Clark seconded the resolution, which was carried unanimously. The retiring director and auditors were then re-elected.

CASTNER KELLNER ALKALI CO. (LTD.)—The Right Hon. G. W. Balfour, who presided over the meeting on Friday, said the net profit, after making allowances for repairs and maintenance, &c., was £263,321. It was proposed to pay a final dividend of 11 per cent., making 20 per cent. for the year, and the balance forward was £45,078. The drop in the dividend from 22 to 20 per cent. was not due to any diminution in the company's earning power, but was owing to the effect of the excess profits duty. They had expended about £200,000 in extending their plant just before the war began, but as they had not yet begun to reap the benefit of that expenditure their pre-war standard of profits, which formed the basis for calculating the excess profit duty, was considerably less than they might fairly have expected it to be had the extension of plant been in operation during the years immediately preceding the war. It was true that certain allowances were made by the Treasury to meet such cases, but in the case of their company he had little doubt that the allowances had fallen short of what the additional plant was capable of earning. On the whole, he was inclined to believe that the war had not been a source of gain to the company. If, on the one hand, there had been no large Government orders and no artificial raising of prices and, on the other hand, no excess profits duty, their [illegible] profits would have been certainly no worse and perhaps actually better than [illegible]. By far the larger portion of their output now went [illegible] required by the country [illegible] the war. Moreover, they were now engaged in the erection of [illegible] plant [illegible] to meet further requirements of the Ministry of Munitions. The [illegible] between Messrs. Brunner Mond & Co. and themselves was already in a fair way to realise the good results anticipated from it.

FRASER & CHALMERS (LTD.)—The profit for the year ended June 30 was £30,174, compared with £21,698 for the previous year, and after paying the preference dividend of 7½ per cent., the directors recommend payment of a dividend of 5 per cent. (less tax) on the ordinary shares. A sum of £20,000 has been placed to reserve and the balance (£16,772) carried forward.

NEW TRANSPORT CO. (LTD.)—The directors, in submitting the accounts for the year 1916, report that further work of an important character has been done since the last meeting. The directors have individually done all in their power to forward the propaganda work, and Mr. Arthur Reed Ropes, Mr. Henry Murray, Mr. Whateley C. Arnold and Mr. H. M. Hyndman and many others have continued their valuable activities. In several magazine articles Mr. Gattie's scheme has been approved, and other propaganda work has been carried out during the year, including lectures before the Royal Colonial Institute, the National Union of Railwaymen and the Society of Engineers. From America there has also been a demand for information, and the company is in correspondence with the Commonwealth of Massachusetts. Dr. Hele-Shaw has joined the company in the capacity of mechanical engineer. Acting on the suggestion of Mr. Walter Roch, M.P., the London and District Goods Clearing House Railway Bill has been drafted by the company's solicitors. On Nov. 23, 1917, Mr. Walter Roch, M.P., introduced a deputation to Sir Albert Stanley, President of the Board of Trade, at which the proposals of the company were discussed.

MORTGAGES AND CHARGES.

GAVAN INRIG (LTD.)—Particulars of £200 debentures created Oct. 11 1917, have been filee, whole amount being now issued. Property charged: Company's undertaking and property, present and future, including uncalled capital. No trustees.

GENERAL CABLE MFG. CO. (LTD.)—Debenture for £1,500, dated Nov. 6, 1917, charged on company's undertaking and property, present and future. Holders, T. Cohen & Co. (Ltd.)

ISLE OF THANET ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.)—Agreement dated Oct. 25, 1917, to issue £3,000 debenture stock for a loan of £1,500. Property charged: Company's undertaking and property, present and future. Holder: J. B. Glenn.

RECEIVERSHIP.

ELECTRICAL ACCESSORIES MFG. CO. (LTD.)—E. Fisher, 12, Cherry-street, Birmingham, ceased to act as receiver or manager on Oct. 31, 1917.

SHIPSTON ELECTRICAL CO. (LTD.)—A. E. Mason, 193, Wolverhampton-street, Dudley, ceased to act as receiver or manager on Oct. 22, 1917

CITY NOTES.

ADELAIDE ELECTRIC SUPPLY CO. (LTD.)—The directors have declared a final dividend on the ordinary shares of 7 per cent. (tax free), making 12 per cent. (tax free) for the year ended Aug. 31.

BRAZILIAN TRACTION, LIGHT & POWER CO. (LTD.)—The directors have declared a quarterly dividend of 1½ per cent. on the cumulative preference shares.

COMPANIES STRUCK OFF THE REGISTER.—The following were struck off the Register of Joint Stock Companies on Nov. 30: Advisory Engineers' Corpn., All British Electrical Co., Alphons Custodis Chimney Construction Co., Fletcher's Electric Fittings, Magneta Time Co., Midland Magneto Co.

GLOBE TELEGRAPH AND TRUST CO.—A quarterly interim dividend of 2s. per share has been declared on the ordinary shares, tax free.

W. T. HENLEY'S TELEGRAPH WORKS CO. (LTD.)—We are informed that, owing to advanced age, Mr. Sydney Gedge has decided to relinquish his position as Chairman of this Company as from Jan. 1, 1918. Mr. Gedge has been a director of the company for 37 years and has been chairman for 30 years. The company will still have the benefit of his long experience on the Board. The Managing Director of the company (Mr. George Sutton), who has been in the service of the company for upwards of 36 years, has been elected as Chairman from the time of Mr. Gedge's retirement. Mr. Sutton will hold the position of Chairman and Managing Director.

MARCONI'S WIRELESS TELEGRAPH CO. (LTD.)—It is announced that terms have been settled between the United States Government as to the remuneration and compensation to be paid to the company in respect of all the company's wireless stations.

MELBOURNE ELECTRIC SUPPLY CO. (LTD.)—The directors have declared a final dividend on the consolidated ordinary stock of 5 per cent. (tax free), making 10 per cent. (tax free) for the year ended Aug. 31.

METROPOLITAN CARRIAGE WAGON & FINANCE CO. (LTD.)—An interim dividend of 1s. per share (tax free) has been declared.

PROVINCIAL TRAMWAYS CO.—A final dividend of 10d. and a bonus of 6d. per share has been declared on the ordinary shares, making a total distribution of 2s. per share—*i.e.*, 10 per cent. per annum, for the year ended Sept. 30.

WESTERN TELEGRAPH CO. (LTD.)—The directors have declared the first quarterly interim dividend of 3s. per share (tax free) for the year ending June 30, 1918, being at rate of 6 per cent. per annum. The transfer books will be closed from Dec. 13 to Dec. 19, inclusive, and the dividend will be payable on the 20th inst.

THE ROUND TABLE.

By "KVA."

MOTTO FOR THE WEEK.—Buy Tank War Bonds and think yourself lucky the war is in the hands of the Engineers.

* * * *

Among the rank and file of workmen, the Amalgamated Society of Engineers is often referred to as the Algamated Society, and I suppose the "Daily Telegraph" has a member among its composing staff, for in its issue of December 4th the word is spelt in this way. When every workman has his own motor car, and has re-treaded tyres, the tendering of the word will then be the Almagam-ated Society!

* * * *

She had no use for slackers, who dared not to enlist,
She vowed no stay-at-homer would e'en by her be kissed.
She doted on the army, and loved the engineers,
But when stern duty called them, her eyes were dimmed with tears.
An ensign came to woo her, she found him strong and brave,
And for a time thereafter, o'er navy she did rave.
At last the smiles came flocking, to cry she thought absurd,
She met an aviator and thought he was a bird.

"State Street" in "Edison Life."

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN, December 11, 1880.]

MR. SWAN'S PATENT. The mystery of Mr. Swan's carbons is, we are told, at length disclosed. They are made of vegetable parchment—commonly called parchment paper—cut into strips and carbonised; they are then bent to the required shape and fixed inside the exhausted globes in the manner publicly described by Mr. Swan. The so-called vegetable parchment is paper prepared with sulphuric acid, whereby it becomes exceedingly tough and compact.

PARLIAMENTARY INTELLIGENCE.

SCIENTIFIC AND INDUSTRIAL RESEARCH WORK.

In the House of Commons last week Sir PHILIP MAGNUS asked the Secretary of State for the Colonies [illegible] system of co-ordinating the research work now being conducted in the laboratories of our universities, in the National Physical Laboratory and in the Imperial Institute was being or had been arranged, more especially with a view to bringing the results of [illegible] with further problems connected with [illegible] and with our productive industries in the country [illegible] Dominions overseas, and whether opportunities are afforded [illegible] of our manufacturers scientific experts [illegible] in their factories special investigations, and, if so, under what conditions.

In reply, the Under Secretary of State for the Colonies (Mr. HEWINS) [illegible] and the Committee of the Privy Council for Scientific and Industrial Research were, in the course of [illegible] information as to research being conducted [illegible] places and different types of institution, which could not [illegible] the co-ordination of research work which the hon. member desired. Moreover, [illegible] had come or were coming [illegible] in other parts of the Empire which were in close relation [illegible] Research Department of this country. [illegible] of Science and Industry [illegible] Journal of Industry [illegible] who were engaged in the [illegible] Empire, and with the [illegible] of the Research Department [illegible] manufacturers [illegible] their factories special [illegible]

London-Glasgow Telephone Service.—In the House of Commons last week the Postmaster-General stated, in reply to a question, that ordinary calls between London and Glasgow were subject to somewhat heavy delays, mainly owing to [illegible] and, in some measure, to [illegible] weather conditions. Only urgent Government business received priority, and every effort was made to reduce the length of calls to a minimum. A large number of Government messages were transmitted by telegraph.

Non-Ferrous Metal Industry Bill.—In the House of Commons on Monday the President of the Board of Trade (Sir A. Stanley) moved the second reading of this Bill, and explained that the measure was brought forward in conformity with the resolution of the Paris Economic Conference, which imposed upon the Allied Governments the duty of making their countries independent of our present enemies as regards the control of essential commodities. Of these none were more important than the non-ferrous metals, especially spelter, lead, copper, aluminium and tin.

Several members criticised the measure, and Mr. J. M. HENDERSON said if all that the President of the Board of Trade had said was true, it was a serious reflection on our traders; but it was not true. America and Japan had the control of copper, France and Canada had the supply of the whole of the nickel, and if those countries did not exercise control, whose was the fault? At present, owing to war [illegible], we had control over every metal, with the possible exception of tin, and the real object of the Bill was to control the trade after the war.

Sir F. BANBURY moved the rejection of the Bill, and after Dr. ADDISON had spoken in support, the debate was adjourned.

PARLIAMENTARY NOTICES.

The following additional notices of intention to apply for powers for electricity supply, electric traction undertakings, &c., have appeared:—

JOINT ELECTRICITY SUPPLY AND TRACTION BILLS.

In the Sheffield Corporation Bill power is sought for the consolidation, amendment and repeal of various Acts and Orders, to give powers for the continuance and maintenance of tramways, trolley vehicles and motor omnibuses, and to construct and work new tramways and omnibus services within and beyond the city, &c.; also for the continuance, maintenance and improvement of the electricity undertaking; to authorise the construction or the completion of electric lines in the city and the county borough of Rotherham, and to provide shops and other conveniences in connection with any buildings held with or forming part of their electricity undertaking; to supply electricity in streets not dedicated to public use, to give a supply of energy to the Midland Railway Co., to supply electricity in bulk to local authorities of districts adjacent to or near the city, to afford supplies beyond the limits of supply to certain premises, and for working tramways; to empower the Corporation to provide, sell, let for hire, fix, remove and repair lamps, meters, electric motors and apparatus, cooking, heating, lighting and motive power.

In the Bill of the Pontypool Gas and Water Co. power is sought to [illegible] on the undertaking and the supply of electricity, &c.

A Bill [illegible] of a wharf, dock, railways and other works, including generating stations, on Canvey Island, to confer powers for the working of the railways by [illegible] electrical energy, &c.

[illegible]

[illegible] Havland [illegible] Ltd. (for Doncaster Rural [illegible]

LEGAL INTELLIGENCE.

Attorney-General (ex rel. Gas Light & Coke Co.) v. Hackney Borough Council.

The Court of Appeal (Lords Justices Swinfen Eady, Warrington and Scrutton) on Nov. 29 commenced the hearing of the appeal of the Gas Light & Coke Co. from the judgment of Mr. Justice Astbury, reported in The Electrician of Aug. 3 last.

Mr. Colefax, K.C., in support of the appeal, said Mr. Justice Astbury had dismissed the action, with costs, and, shortly stated, the point had reference to the charges for electricity that were made by the Metropolitan Borough of Hackney—whether or not in their charge for power they infringed the provisions of the secs. 19 and 20 of the Electric Lighting Act, 1882. Plaintiffs' submission was that Mr. Justice Astbury had not given effect to the judgment of the Court of Appeal in the Long Eaton case, and, further, that he had unduly made distinction between that case and the present one. In the Long Eaton case the facts were that persons using power for running their lace machines if they took all their light from the company got it at a cheaper rating, while, on the other hand, if they only took it for one purpose they did not get it on the cheaper rate. The Borough of Hackney had given to the power user a charge in respect of lighting up to the extent of 20 per cent. of the energy users' other charge, thereby giving the user a benefit over one who only took electrical energy for light. The charges were divided under two heads, one for light and one for power, with alternation for lighting, and the circular of which his clients complained in the present proceedings went on to say that consumers paying under this scale (that was for power) were allowed to use 20 per cent. of the energy consumed for lighting. Prior to the action being brought the circular had been amended by stating that in respect of the power charge limiting the right to take 20 per cent. of the energy for lighting that it should be taken from the factory were the power was used and from the same meter. There was in reality no change, only an alteration in the wording of the circular. Practically the 20 per cent. was a maximum figure for a factory for lighting purposes.

Lord Justice Warrington: They get their lighting for nothing if they pay for power?

Mr. Colefax: Not quite so; they pay ½d. per unit.

Lord Justice Warrington: A halfpenny per unit would cover the cost of both lighting and power.

Mr. Colefax agreed. He said that the circular stated (this was what the plaintiffs complained of) that for power "a fixed charge of £1 per quarter per kilowatt of maximum power demanded and a charge for electrical energy used of ½d. per unit; consumers paying under this scale are allowed to use 20 per cent. of the energy consumed for lighting." Plaintiffs admitted that a power user in respect of electrical energy for power had a better load factor and a better diversity power than a light user under ordinary circumstances; but the power user when he used light worsened the position at the central power station, and in fact *qua* the user of light he was no better for the power station—if so good—than the ordinary user of light and the non-power user of light. His (counsel's) broad point was that the Borough of Hackney, having regard to the Long Eaton case, was not entitled to give to a power user a preferential charge in respect of light.

In reply to Lord Justice Swinfen Eady as to what was the current charge for light, Mr. Colefax replied that a non-power user using light paid twice what a power user would pay for light. He did not complain of there being a cheaper rate for power than for lighting—that was a proper distinction to be drawn, as the two were not similar—but he did object to the 20 per cent. privilege, as that would give to a power user a preferential charge for light as contrasted with a non-power user, and was an inducement to the power user to cheapen the cost of his power by taking light without any corresponding benefit to the station. In the Court below evidence was given to the effect that the charges of the Hackney Borough Council for power resulted in a loss, but as the learned judge was of opinion that the evidence was irrelevant, he (counsel) should not go into that part of the case. He contended that the present case was on all fours with the Long Eaton case. Counsel said there was no dispute as to the meaning of the phrases "load factor" and "diversity factor" and he thought the evidence proved that power users as a class had a better diversity factor than light users. He had proved by the evidence of Sir John Snell at the trial that the load factor of a power user was worsened when he took light. He recognised that the load factor of a factory taking light and power would probably be better than the load factor of a concern taking only light, but the question of how far that was relevant depended upon the Long Eaton judgment. When a consumer used power only he got no better terms however much he used, but he got better terms if he used light and power and that was what his clients complained of. What the Long Eaton circular did was to offer to allow the power user to have his units cheaper if he said he would take his light as well, and that was held to be wrong. It was admitted that respondents were quite entitled to have a tariff, viz., a

tariff for light, a tariff for power, and a tariff for both light and power. They did not do that, but had held out an inducement to the power user to adopt light, and that he submitted they could not do.

On Friday, Mr. WALTER, on behalf of respondents, said appellants' case was based on a misconception as to the true effect of sections 19 and 20 of the 1882 Act. What they had sought to do was to read the Act as though the sections were not framed to prevent different charges to different consumers, but between a different consumption. Electric supply undertakings supplied one thing, and that was electricity. The only interest it had was in the use of the energy supply in so far as that use affected their cost of supply. It was commonly supposed that because a light consumer paid a higher price he was a better customer than the power user. The contrary was the fact. An electric light undertaking had to be upon a scale so as to meet the maximum demand which might at any time be imposed on the station. Usually the maximum demand occurred about 6 p.m., and in the case of Hackney it was 5,245 kw. An electric light undertaking had a building in which there were large engines, dynamos and various other machines which had to be on a scale to meet the maximum demand which at any time might be imposed on the plant; that was of fundamental importance in considering the question of cost. In the case of Hackney, on July 24, 1914, the maximum rose to 5,245 kw. In all electrical stations the expenses were divided between capital charges (interest and sinking fund, depreciation), charges which went on whether they generated little or much electricity. In the present case the cost was £8 per kilowatt per annum as standing charges, no matter what amount of current was supplied. The ordinary lighting was only about two hours a day, taking the year right through. That meant that the capital expenditure was only being utilised for two hours out of the 24, if you depended only on light consumers. Therefore all electric light undertakings endeavoured as far as they could to extend the useful work of their stations. For that purpose they endeavoured to procure loads to supply energy at different hours in the day from those at which the light producers came on. What it came to was this: The respondents were sellers of energy and nothing else. With the exception of defining the price they could charge, they had no concern with what anybody did with that which they sold them. What the Court was asked to say was that the customer who used the plant for but 2 per cent. of the 24 hours could not be charged differently to the man who used the plant for 11 per cent. of the 24 hours. That was really what appellants were asking. All the authorities were absolutely in favour of respondents. If they had to make separate charges to consumers who used both power and light—charge them differently for each—they would have to have separate meters and separate wirings, which would probably cost thousands of pounds. The Act of Parliament had nothing to do with power, nothing to do with light and nothing to do with charges. Sec. 27 of the Hackney Provisional Order enabled the undertakers to charge for the energy supplied by them. The only thing they sold and agreed to supply was electrical energy. They had power to distinguish between the classes of consumption and the classes of consumers. There was no such distinction known as a differentiation between power and light for the purposes of the Act. No evidence had been given at the trial that there was any undue preference.

The case had not concluded when we went to Press.

An Electricity Meter D'spute.

On Wednesday a Divisional Court (Justices A. T. Lawrence and Shearman) heard the appeal of the Hendon Electric Supply Co. from a decision of the County Court Judge at Barnet in the action of the company against Walter Banks, of the Hampstead Garden Suburb.

Sir E. Pollock, K.C., M.P., and Mr. Ball were for appellants and Mr. Emery for respondent.

Sir E. POLLOCK stated that appellants brought an action in the County Court to recover £3. 6s. 5d. in respect of electricity supplied to defendant. The County Court judge held that plaintiffs were not entitled to recover, holding that the electric lighting order applying to the case laid down that the dispute and the ascertainment of the amount was first to be made by an electrical inspector within the meaning of the Act, and that as that had not been done plaintiffs were disentitled to proceed with their claim, but the County Court judge gave leave to appeal. If the decision stood, it fettered to a large extent the powers of the company to recover against the consumers of their electricity. The defendant was a resident within the area supplied by the Hendon Electricity Co., and in June of last year a new meter was fixed upon his premises. It appeared

that when the meter was fixed they forgot to take out the locking screw, the result of which was that the meter did not register. At the end of the quarter, in September, not much remark was made at the fact that no electricity was registered as having been consumed, but when the December quarter came, and again no electricity was registered as having been consumed, the company were surprised, and on Feb. 22 they sent an inspector, who found that the meter was not working, and he pulled out the locking screw. Then the question arose as to how to ascertain the amount of the electricity which had been consumed. The company claimed in accordance with the Act and the contract on the basis of the consumption in the corresponding quarter in the previous year.

Mr. EMERY, for respondent, said there were several meters in the house, and the one in question controlled a heating apparatus which defendant said were not used during the periods in question.

Sir E. POLLOCK said a letter had been written since the trial at Barnet, in which it was agreed that the County Court judge held electricity had been used through this meter in the periods in question.

Mr. EMERY, dissenting from that, said the County Court judge made no finding of fact at the trial, but afterwards, when plaintiffs asked for leave to appeal, he made some remark to the effect that if he had found any question of fact he should have been inclined to find that some current had been used, but at the actual trial he found no question of fact; but with the question of law gave judgment for defendant, without costs.

Sir E. POLLOCK: The defendant, by contract in writing dated March 20, 1915, agreed to take a supply of electricity upon certain conditions, under which defendant agreed to the supply being ascertained by the meters provided by the company, and in the event of any difference as to the correctness of the meter registering accurately, the dispute was to be settled in the manner provided by the electric lighting Acts. One of the clauses of those Acts provided for the appointment of an inspector to ascertain the amount of electricity which would have been consumed if the meter had been working; but no inspector had been appointed.

Justice SHEARMAN: If an inspector was appointed you would have to pay his salary, and that would probably be larger than the amount you would receive under his award.

Sir E. POLLOCK pointed out that if an inspector were appointed the consumers would have to pay the costs if they had acted unreasonably in raising a dispute before him. And in the ordinary case the inspector would have no power to give judgment. All he could say was whether the meter was right, and then the company could sue the consumer.

Justice LAWRENCE, in his judgment, said plaintiffs alleged that the meter was not in action by reason of a screw having been left in, and defendant denied that he was using the meter, and that its record was binding upon the company. Such a dispute has been provided for by clause 57 in the schedule of the Electric Lighting Act of 1899, and that provided that where a difference arose between the consumer and the undertakers as to whether any meter whereby the value of the supply was ascertained was not in proper order for correctly registering that value that difference should be determined upon the application of either party by an electric inspector, or, where the local authority are the consumers, by an electric inspector to be appointed by the Board of Trade, and that inspector should order by which of the parties the costs of and incidental to the proceedings before him should be paid, and the decision of the inspector should be final and binding on all the parties, subject to which the register of the meter should be conclusive evidence in the absence of fraud. There was no question of fraud. Therefore the register of the meter was conclusive, subject to the decision of the electrical inspector. A determination by the inspector was demanded by the consumer in the present case, and, unfortunately, no electric inspector had at that time been appointed. He did not see that that entitled the County Court judge to assess the amount of electricity consumed. He was bound to say, as he did, that the Act of Parliament had itself provided for the mode of determining such a dispute, and that until it was so determined no cause of action arose. He did not see why it could not still be determined, and then a cause of action would arise; but that point had not been argued, and therefore he did not judicially decide it.

Justice Shearman agreed, and the appeal was dismissed, with costs.

A Partnership Dispute.

On Friday Mr. Justice Astbury granted an injunction restraining Taylor & Co. (Hatton-garden), Ltd., and Miss Julia Taylor and Ernest W. Tester, the signatories and shareholders of the company, from using the name "Taylor & Co. (Hatton-garden), Ltd."

Mr. T. RUSSELL, K.C., who appeared for the plaintiff, Moritz Bergl, said that in 1912 he came in touch with Miss Taylor, who was the sole owner of the mica business of Taylor & Co. They entered into a partnership, which eventually was dissolved, and the partnership assets were to be sold. In the meantime defendants had registered the name of defendant company, and he submitted that no one knowing that a company with that name had been formed would bid at the sale of the partnership goodwill, and the sale would be prejudiced by the name being allowed to remain on the register.

Mr. RAM, for defendants, said Miss Taylor had not intended to do anything wrong, and she hoped that no one from the outside would attend the sale and that she would secure the business. She intended to do nothing with the company until the sale was completed.

His LORDSHIP granted an injunction with costs.

Both parties then agreed to the appointment of a receiver of the partnership business.

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CONTENTS.

NOTES.

Electric Cooking.

LAST week Mr. W. A. GILLOTT read before the Institution of Electrical Engineers an interesting Paper on electric cooking and prefaced his Paper by a short account of the developments which are taking place. He mentioned that in Newcastle arrangements are now in hand for serving 12,000 persons by means of electric kitchens, and that this will provide a load of 1,000 kw. Moreover, Newcastle is not the only city in the country where progress of this kind is to be found. When industrial kitchens and installations for restaurant equipment varying from 100 kw. to 200 kw. and more per kitchen are being laid down it does not take long to obtain a substantial load. Those who see nothing in electric cooking, or only sufficient to pass it by with a little mild scorn, will soon come to the conclusion that electric cooking has come to stay. In his requirements for successful service, Mr. GILLOTT places reliability first, and in this we think he is undoubtedly right. It is quite essential that the plant used should not give trouble. Mr. GILLOTT gives an analysis of the faults occurring in the installations he describes, and it is noticeable that quite a large proportion of these are wiring faults. This, it seems to us, must be due to lack of proper design. We all know how the old switchboards used to be erected with a [illegible] tangle of wires behind them, with a result that wiring faults were not uncommon. This class of work has given way to work of a different kind, in which such faults are impossible, and we suggest that plant for electric cooking must follow somewhat similar lines, so that wiring faults are eliminated. If faults occur they should be limited to the failure of elements. In the discussion on this Paper the opinion was expressed that the cost of power was not a material factor, owing to the inherent advantages of electric cooking. Up to a point this may be true, but the cost of power is, nevertheless, an important matter. There is no doubt that our most progressive companies and municipalities are doing all they can to reduce the price at which power can be supplied. That this is so is indicated by many advertisements which appear in our present issue, all of which indicate that the supply authority has this point strongly in mind. The advertisements in question have reference more particularly to cheap power for industrial purposes, but there is no question that if power is supplied cheaply for factories it will be equally beneficial for the large electric kitchens which so many factories are now using.

The New Patents and Designs Bill.

THERE are many points of interest and importance in the new Bill which has been introduced by the Government to amend the Patents and Designs Act, 1907. In our present issue we can only deal with one or two of these. The most important amendment is that which, on the one hand, encourages the working of inventions, and, on the other hand, prevents the abuse of monopoly of rights. There are many difficulties involved in the question of compulsory working of patents. It may sometimes be contended that the inventor does not take the necessary steps to have his invention taken up, though we think it will be generally agreed that the average inventor is only too anxious to be in a position to receive royalties. In any case, under the new Bill the inventor will be in a position to remove this suspicion because he will have the right to have his patent endorsed by the Controller with the words "licences of right." In such cases any person will be entitled to a licence under the patent, upon such terms as may be fixed by the Controller. In fixing these terms the Controller must, on the one hand, endeavour to secure to the patentee the maximum advantage [illegible] and, on the other hand, to ensure the widest possible use of the invention in the United Kingdom. [illegible] as far as possible, which is a somewhat difficult matter. In the event of a patentee not taking advantage of this provision, and in the event of no satisfactory reason being given for the non-working of his patent in the United Kingdom, the Controller will be at liberty to endorse the patent in the same way, so that what cannot be voluntarily [illegible] compulsion for the good of the community.

The Electrician.

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THE HANDLING OF MATERIALS.

In the present issue will be found a number of articles devoted to the description of the machinery and methods used for the handling of materials. Under normal conditions we should have given even more space to such articles. but under existing restrictions we have felt compelled to limit the number of our pages severely, even to the exclusion of many of our usual features, so that the articles on the handling of materials might be as comprehensive as possible. Few subjects are of greater importance. Practically without exception the machinery described is electrically driven, and must be so driven to ensure success.

In closing the discussion on a Paper read before the Institution of Civil Engineers in 1856—a discussion in which many celebrated men had taken part—that eminent engineer, Robert Stephenson, said :—

"There could be no doubt . . . that the application of voltaic electricity, in whatever shape it might be developed, was entirely out of the question commercially speaking. Without, however, considering the subject in that point of view, the mechanical applications seemed to involve almost insuperable difficulties. The power exhibited by electro-magnetism, though very great, extended through so small a space as to be practically useless."

Thirty-three years later, before the same Institution, no less a distinguished engineer than Lord Armstrong said :—"He felt satisfied that in point of safety, controllability and adaptability to various purposes, electricity had little chance of ever rising to the level of hydraulic power."

Even in 1906, Mr. Henry S. C. REE, chief engineer to the Cardiff Railway Co., expressed similar views, and in 1911 Colonel F. W. TANNETT-WALKER still preferred hydraulic plant for dock equipment.

Truly "The prophets have seen vain and foolish things for thee : and . . . have seen for thee false burdens."

Notwithstanding the fact that progress at home has been retarded by prejudice, the present position is that in every case where motive power beyond manual capacity is required for driving a crane, a hoist, a conveyor or a capstan electrical energy should be used if a supply is available. We would go further and state that where a supply is not available it is often good engineering to create a supply by installing electric generators. With the single exception of coal handling plant, electrical energy is now generally used at [illegible] for driving machinery intended for handling [illegible] in bulk. Even in coal handling there are signs which indicate that the more progressive of our port and [illegible] authorities are learning a lesson which has long been [illegible] to many engineers on the other side of the Atlantic and to a few on this side—namely, that electrical energy is indispensable for the economical handling of coal.

Mr. H. H. [illegible], the chief engineer to the North Western Fuel Co., St. Paul, U.S.A., is well qualified to deal authoritatively with the handling of coal and iron ore, and [illegible] what has been done and what is being done in the States. Of the many striking instances of rapid handling the following may be cited:— [illegible] in 7 hours and 58 minutes, [illegible] 11,000 tons of ore in one hour and leaving the [illegible] 1 hour and [illegible] minutes from the time of arrival. Another fine record is the loading of 9,500 tons of ore in [illegible] minutes actual loading time. Depending upon the character of the ore and local conditions, the usual time for loading a 10,000 to 12,000 ton boat is said to be three to six hours. That British engineers are not unmindful of this important subject is shown by Mr. F. G. MITCHELL in an article on "Belt Shipping Plants."

The results obtained in the handling of coal and ore in America are due in part to the adoption of electricity as a motive power. Another factor which has contributed largely to the success is the close co-operation of the harbour authorities, the railway companies, the engineers in all branches of engineering and the naval architect.

In his article on the "Electrically-driven Crane," Mr. H. H. BROUGHTON rightly points out that the installation of modern machinery at a port does not ensure the rapid handling of cargoes unless the transport arrangements are efficient and sufficient. The figures which he gives for the port of Genoa are very striking, and the authorities at that important port are to be complimented on their enterprise.

That the transport arrangements, both in this country and on the Continent, are neither efficient nor sufficient is well known to those who have occasion to use the railways and waterways in normal times. Under heavy pressure the arrangements have been deplorable. Time after time we have heard that boats have been held up at the ports for a whole month owing to congestion. To remedy the evil the proposal has been made to employ manual labour "very freely," but this is not a true remedy.

The machinery to use in the handling of cargo is the crane, the elevator and the conveyor. Mr. C. M. TOPLIS, whose crane is one of the most efficient in existence, shows what is being done by cargo cranes, and draws a comparison between steam, hydraulic and electrical methods of operation. His remarks on British and Continental practice will be read with interest.

Individually the railway companies are striving unceasingly towards more efficient methods. Mr. ROGER T. SMITH gives examples of such methods as practised by the Great Western Railway Co., and expresses the opinion that electricity is superior to any other motive power for such purposes. Records are reproduced which show the electrical input to certain of the machines which he describes. What the railway companies are striving to do individually Mr. A. W. GATTIE would have them do collectively. His article on the subject makes interesting reading.

Striking examples of the conveyor applied to the handling of foodstuffs are given, and Mr. W. H. ATHERTON traces the evolution of the coal conveyor and elevator as used in power houses. Reference must also be made to the article on "Ropeways," by Mr. J. W. WHITE, and to that on "Telphers and Transporters," by Mr. G. F. ZIMMER. All these appliances also are invaluable aids to the handling of materials.

When material has to be moved in a factory from one department to another, not connected by crane or conveyor, works managers are enthusiastic in their praise of the electric battery truck. Mr. R. J. MITCHELL reviews the progress in this field during the past three years, and describes typical installations where the electric vehicle is rendering service which is otherwise unobtainable.

In closing this somewhat hurried survey of the ground covered by the present issue, we would say that the principle of mechanical handling applies equally to all cases where materials have to be moved from place to place. For the most part the examples given deal with heavy machinery, but the same elementary principle applies when the loads are light, more particularly where the operation is continuous. The object in view throughout should be the elimination of the human element and the utilisation of this element for a more useful purpose.

Lessons from America in the Handling of Coal and Iron Ore.

By G. H. HUTCHINSON, M.A.S.C.E.
[illegible] Engineer, N[illegible]

Summary.—Of the total iron ore shipped in the United States, which amounted to 77,870,[illegible] per cent. came from the Lake Superior region. Consequently, the methods of [illegible]. The normal time for loading a 10,000 to 12,000 ton boat is only from 3 to 6 hours. Mining is carried out by open pit, shaft or milling, according to circumstances. In this connection special mechanical devices are used. The docks are specially constructed for dealing with ore and are equipped with towers, bridges, locomotive cranes, conveyors, elevators and cable car systems. Similar plant is used for handling the heavy traffic in coal. Typical illustrations are given of the plants in use for both ore and coal.

The scope and brevity of this article necessitate the omission of practically all detail, that would otherwise be of interest and benefit, and permit limited reference only to the more essential features of the equipment and methods in use in the handling of coal and iron ore. The photographic illustrations, with somewhat full descriptive titles, will supplement the brief outline in the text and give some idea of the various types of equipment and operating methods.

In view of the magnitude of the iron ore traffic of the Lake Superior region and the variety of operations incident thereto, it will simplify the treatment of the subject, and better serve the purpose of this article, to limit our consideration of the operations and methods in ore handling to this district alone, from which was shipped in 1916 about [illegible] per cent. of the entire output of the mines of the United States, a total of 77,[illegible] gross tons.

The Lake Superior region comprises six iron ranges, known as the Marquette and Menominee ranges in Michigan, the Gogebic in Wisconsin and the Vermilion, Mesabi and Cuyuna in Minnesota. Iron ore was discovered here in [illegible] and in [illegible] the first shipment of half a dozen barrels was made to Pennsylvania. Of the six ranges named, the Mesabi is the largest producer, having shipped in 1916 over 42 million tons of ore, while the Hull Rust mine alone on this range shipped during the same period [illegible] tons, being the world's record to date for a year's shipment from a single mine.

The remark made by a visiting [illegible] [illegible] [illegible] [illegible] [illegible]

[illegible] far-reaching river system, facilitating inland transportation to an unusual extent. The entire condition offers an incentive to the development of equipment for the rapid and economical handling of the enormous tonnage involved.

Achievements in Handling Cargoes.

That the evolution of methods and development of facilities in the ore industry have kept pace with the increase in the volume of ore traffic is believed from the following to be evident. The tonnage of iron ore from the Lake Superior region increased from [illegible] in 1855 to about 36,000 tons in 1860 [illegible] [illegible]

The vessel "W. P. Palmer" [illegible] Conneaut Harbour, Ohio, [illegible]

In August of the present year the vessel "[illegible]" [illegible] Duluth [illegible] Superior Harbour [illegible] [illegible] coal [illegible]

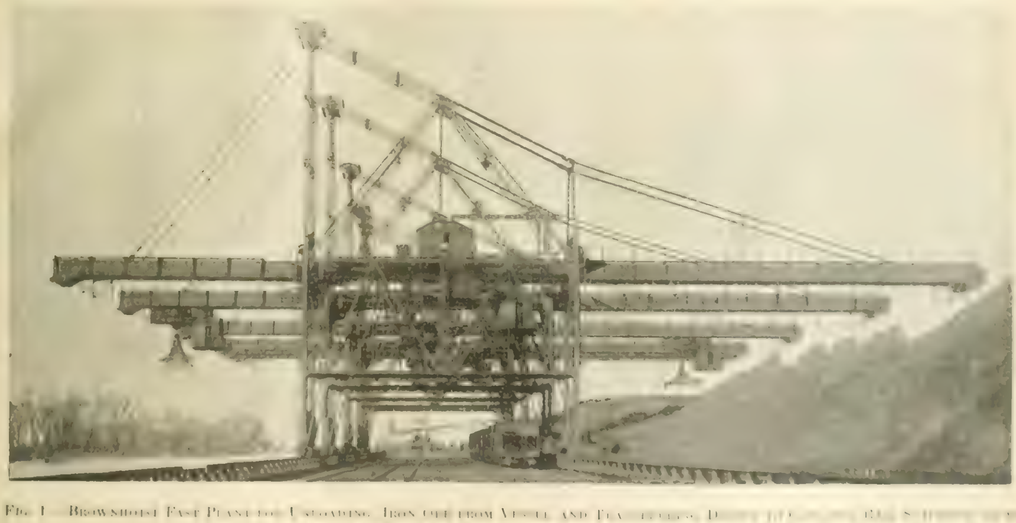


Fig. 1.—Brownhoist Fast Plant for Unloading Iron Ore from Vessel and Transferring [illegible] Discharging to Dock for Rehandling and Stocking by B[illegible].

In September, 1915, a vessel received a cargo of over 11,0[illegible] tons of ore in 1 hour and left the harbour in 1 hour and 45 minutes from the time of her arrival at the harbour entry.

The steamer "Corey," in September, 1911, was loaded with 9,466 tons of ore in 25 minutes, actual loading time. As much as 7,689 tons of ore was loaded to railroad cars at the mines by a steam-shovel crew in a single shift. In one day's run of 10 hours 15 minutes, the Duluth, Missabe & Northern ore docks loaded to boats 100,095 tons of ore.

During July of the current year there was handled by the Duluth, Missabe & Northern Railway and loaded to vessels at its Duluth terminal docks* "3,543,874 gross tons of iron ore, which means an average of 4,763 tons per hour or a little over 79 tons per minute for the month. It was the biggest month for the D. M. & N. It was the most ore ever shipped from any dock system in the same space of time in history." During the same month the total movement from the Duluth-Superior Harbour was 7,427,138 tons.

The above operating records are not given as representative of average performance, but to indicate what is at times actually done under favourable conditions. The usual time for loading a 10,000 to 12,000-ton boat is from 3 to 6 hours, depending upon the character of the ore and conditions in general.

The milling process of mining is used where the ore is near enough to the surface not to require underground mining, but where the depth of the ore or other conditions make it difficult to lay approach tracks to the mine. In mining by this method, after removal of the overburden, a shaft is sunk, preferably at one side of the ore-bed. Drifts are then run out from the shaft and below the ore and raises put up to the surface of the ore through the ore-bed. In mining, tramcars, or other means suited to the local conditions, are used for conveying the ore to the raises into which it is dumped to the drifts below and taken to the shaft and hoisted to the surface, as in shaft mining.

After stripping or removing the overburden from the ore in open pit mines, which is done by steam shovels or in some instances by the hydraulic process, the ore is loaded to railroad cars by steam shovel and hauled to the mine yard on the surface. There the cars are assembled into trains and hauled to loading docks at the lake front for trans-shipment by vessel to lower lake ports. Heavy charges of powder are frequently employed in the soft ores in open pit and milling mines for loosening up the ore to facilitate steam shovel work. In mining rocky ores blasting is, of course, required for breaking up the ore to permit handling. The rocky and soft ores, when sufficiently lumpy to require it, are crushed at the mines after reaching the surface, and from the crusher discharged to railroad cars for hauling to the docks, as above noted.

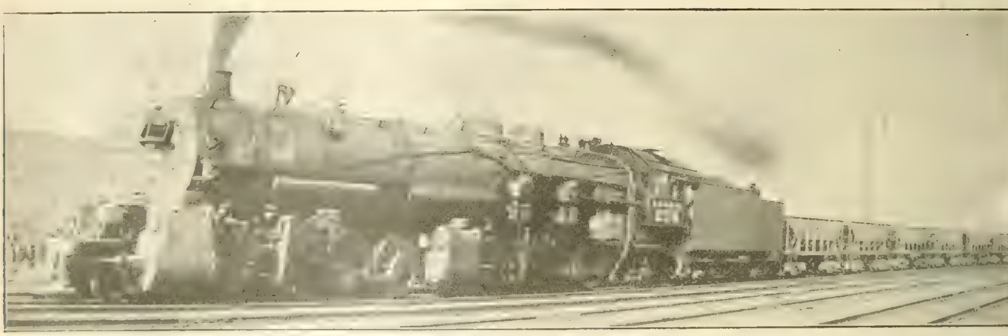


FIG. 2.—DULUTH, MISSABE AND NORTHERN RAILWAY CO.'S 325-TON MALLET LOCOMOTIVE HAULING IRON ORE FROM PROCTOR RAILROAD YARD TO ORE DOCKS AT DULUTH, MINNESOTA.

METHODS USED IN MINING.

In character, physical structure and general appearance the iron ores occurring in the Lake Superior region vary widely from very fine to coarse and lumpy and from soft to hard or rocky ores. The fine, soft ores are frequently sticky or pasty. The cost and manner of handling naturally varies considerably with the different physical characteristics. In colour the ores range from blue and black to brown, purple, red and yellow.

There are three classes of mines, each with its distinctive method of mining, namely, the open pit, shaft or underground, and milling, dependent largely upon the position of the ore body in relation to the surface.

The open pit method is preferred where ore bodies occur near enough to the surface to permit laying of approach railroad tracks having suitable gradients for hauling the ore from the mines to the surface, and where the overburden to be removed does not exceed about 1 cubic yard per ton of available ore. On the Mesabi Range a considerable percentage of the ore is mined by the open pit method, and to a less degree the method is possible on some of the other ranges.

In shaft or underground mining, a shaft is sunk from which drifts are run out to the limits of the ore body. The ore, after being mined and loaded to tramcars, is brought to the shaft, is [illegible] there, and hoisted to the surface, where it is loaded to railroad cars, which are delivered at the shaft or [illegible] from the [illegible] pile.

Ore samples are taken from the cars at the mine yard and sent to the laboratory for chemical analysis, the results of which are telegraphed to the Railroad company's classifying yard, at or near the shipping docks, where the loads are weighed and classified according to grade and discharged to ore dock pockets, in such order as to insure a proper mixture of the several grades. The weighing is usually done while the cars are in motion, the weight of each car being automatically recorded.

The ore railroads connecting the mines with the shipping docks are constructed and equipped for very heavy traffic. The length of haul each way varies from 10 to 127 miles and requires for the round trip from two to three days for the longer hauls. Specially designed hopper bottom and drop bottom cars, usually of steel construction and having actual capacity of 40 to 50 gross tons, dependent upon the specific gravity of the ore, are used for this service. These cars have a coupled length of 24 ft. to suit the 12 ft. pocket spacing in the ore docks, thus permitting the simultaneous discharge to the pockets of the ore from a string of cars. Economy of operation, as well as the dispatch incident to the enormous tonnage, call for powerful locomotives for hauling heavy trains of from [illegible]0 to 135 cars over the steep grades encountered on these lines. These engines are principally of the Mallet or Mikado type, having 10 or 12 drivers and equipped with re[illegible] and superheating devices. On the Duluth, Missabe &

* [illegible] Mining Review, Duluth, Aug. 1, 1917.

Northern Railway, the Santa Fé type of engines is used on the portion of the line having the easier gradients, while on the section having the steeper grades, Mallet engines, having a total weight of about 324 tons, are in service.

In freezing weather it is frequently necessary to thaw the ore in the cars in the dock yards, which is done either in the open by steam hose or in a thawing house specially heated by steam. The thawing house in the dock yard of the Duluth, & Iron Range R. R. Co. has a capacity of 40 cars.

Dock Construction.

The ore shipping or loading docks at the upper lake ports are of four general types of construction :—

For the earlier docks—Timber construction.

For the more recent docks :—

- Structural steel and concrete cast in place ;
- Structural steel with pre-cast slabs ;
- Reinforced concrete throughout.

These docks have, to match the 12-ft. vessel hatch spacing, double rows of pockets on 12 ft. centres, with inclined bottoms

Fig. 3.—Iron Ore Dock with Chutes Lowered for Loading Ore to Vessel, Duluth and Iron Range R.R. Co., Two Harbors, Minnesota.

making an angle of about 47° to 50° with the horizontal. The steel chutes for discharging ore to vessels are operated by electric hoists and the gates controlling the flow of the ore from the pockets to the chutes are so constructed that they may be closed while the ore is running to permit properly trimming the cargo.

The modern docks run about 60 ft. in width by 80 ft. in height above the water and from 1,700 ft. to 2,300 ft. in length, with a storage capacity of about 100,000 gross tons. The individual ore pockets have a capacity of from four to seven [illegible] and vary in number from about 200 to about 384 per dock. The longest dock [illegible] is that of the Minneapolis, St. Paul & Sault Ste. Marie R. R. Co. at Superior, Wisconsin, with a length of 2,412 ft. and 384 pockets having 150,000 gross tons storage capacity. The shipping dock system for each railway at a single port comprises from one to four docks. The storage capacity of the system of four docks of the Great Northern Railway at Superior is [illegible] gross tons, while the seven docks of the Chicago & North Western Railroad at Escanaba, Michigan and Ashland, Wisconsin, have combined capacity of 410,100 gross tons.

In general, ore is transferred from cars to dock pockets and from pockets to boats by gravity. In pasty ores, however, it is necessary to facilitate the process by the use of bumpers for freeing the ore by jarring ; of steel bars for loosening up the ore and of long wooden poles for breaking down arches forming at the pocket gates after the flow has started.

Shipment.

The ore is shipped principally by boat to the ore receiving docks at Lake Erie ports, although a portion is shipped to Detroit, Michigan and to the United States Steel Corporation's plants at Gary and South Chicago on lower Lake Michigan, while a small percentage is shipped by rail from the mines direct to the furnaces, including those of the Minnesota Steel Co. at Duluth.

The shortest water route is from Escanaba to Gary, a distance of 286 miles, requiring 24 hours for the trip. The longest haul is from Duluth-Superior Harbour to Buffalo, a distance of 985 miles, requiring 96 hours for the trip. The average haul for lake vessels passing through the Soo Canals is about 824 miles. The steamer "James M. Schoomaker," with a cargo of 14,520 tons of coal, made the trip from Ashtabula, Ohio, to Duluth-Superior Harbour, a distance of about 886 miles, in 3 days, 21 hours and 40 minutes.

There are about 425 vessels in the ore and coal carrying trade, having an aggregate capacity of about 3,[illegible] tons per trip. These boats vary in capacity from about 3,100 to

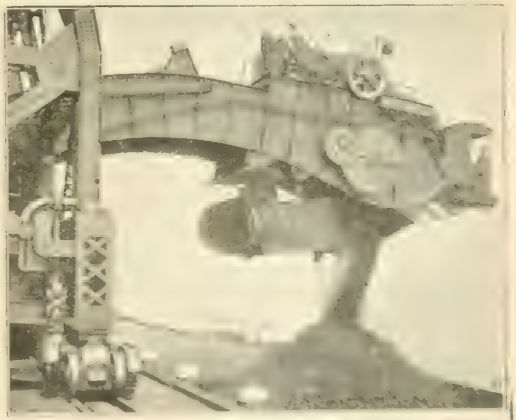


Fig. 4.—[illegible]

13,000 tons on 20 ft. draught, with an average of 7,500 tons. [illegible] shipped from Lake Superior in 1916 would make about 8,000 average cargoes.

All vessel traffic between Lake Superior and the lower lakes is carried on through the Soo locks of the American and Canadian Soo canals in the St. Mary's River at Sault Ste. Marie, Michigan and Ontario. [illegible] An additional lock on the American side is now under construction. In the year 1916, [illegible] tons of freight passed through these canals. [illegible] tonnage being account[illegible]

Dock Equipment for Loading and Unloading.

Modern coal and ore unloading, stocking and reloading equipment, [illegible] power is preferable, [illegible] and provided with

the most effective magetic control and automatic safety devices, and is equipped for power travel along the dock or yard. This equipment is of several types, as follows: Towers, bridges, locomotive cranes, conveyors and elevators, and cable car systems.

Unloading towers or hoists are equipped with man trolleys carrying clamshell grab buckets, which unload the coal and ore and deliver it to railroad cars, either direct or through temporary storage bins, for out-shipment; or to temporary stock piles for rehandling to storage by means of stocking bridges, to be later reclaimed by these bridges.

Bridges are similarly equipped with trolleys and perform the operations of unloading and delivering to railroad cars or transferring to storage piles and later reclaiming the coal or ore for rail shipment.

Fig. 5.—Self Unloading Steamer "W. F. White," Equipped with Robins Belt and Pan Conveyors under Hoppers in Vessel Hold and 60-in. Belt Conveyor on Pivoted Swinging Boom, having 2,000 tons per hour capacity.

Locomotive revolving cranes, travelling on standard gauge or broad gauge tracks, in certain instances meet local conditions better than the types of hoists and bridges above mentioned. They are to a limited extent used in the unloading of vessels and to a larger extent and under certain conditions to considerable advantage in the stocking and reclaiming processes in handling coal. A simple installation may be made by mounting revolving cranes on circular or oval shaped crane tracks, which may be arranged to serve an extensive storage area.

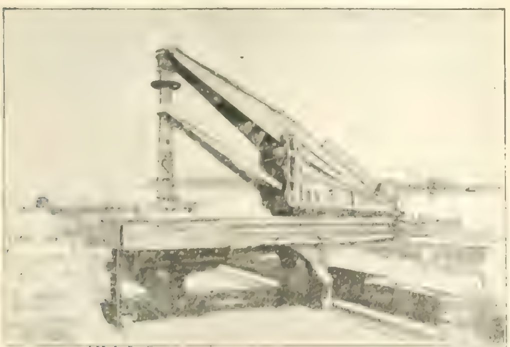


Fig. 6.—[illegible] Hulett Automatic Ore Unloader, Pittsburg and Conneaut Dock Co., Conneaut Harbour, Ohio.

Clamshell Installations.

In another type of installation, a clamshell is used to remove the cargo from the vessel hold and transfer it through storage or concentrating hoppers to a large capacity belt conveyor for carrying to storage piles on the dock. In the reverse process of reclaiming the material is taken from storage piles by the same clamshell and conveyed by belt either to car loading hoppers or to such other points as may be desired. Belt conveyors are also used in a variety of other ways in the handling of both anthracite and bituminous coal. Bucket elevators and flight conveyors are also employed, although their use is restricted ordinarily to the handling of anthracite coal, bituminous screenings and the smaller prepared commercial sizes.

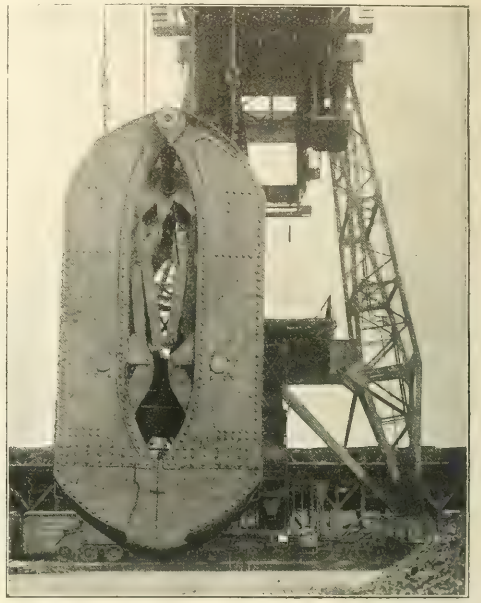


Fig. 7.—Heyl & Patterson 8-ton Clean-up Clam, Closed, on 12-ton Bridge on North-Western Fuel Co.'s Dock No. 1, Superior, Wis.

Another system for stocking coal is used in which the coal, after being unloaded by hoisting towers is transferred to storage by dump cars operated by cable haulage system, either on stationary runways or on travelling bridges serving the storage space.

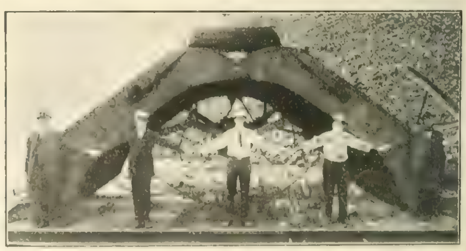


Fig. 8.—Heyl & Patterson 8-ton Clean-up Clam, Open, on 12-ton Bridge on North-Western Fuel Co.'s Dock No. 1, Superior, Wis. Clam when Open has a Spread Lengthwise of Vessel of over 24 ft.

A type of machine at present extensively used in the unloading of ore, and to a very limited extent of coal, from vessels on the Great Lakes, is the Hulett automatic unloader, first installed in 1899 on No. 1 ore dock of the Pittsburg & Conneaut Dock Co. at Conneaut Harbour, Ohio. This first machine was operated by steam and hydraulic power, which was superseded

in the later installations by electric power. This unloading device was a marked departure from the rope trolley rigs carrying dumping tubs, filled by hand shovelling, previously in use. A distinctive feature of this type of machine is a walking beam mounted on a trolley travelling on portal pier girders to and from the vessel. At the outer end of this walking beam is suspended a rotating leg fitted at the foot with a special type of clamshell bucket, having wide-spread for reaching a large percentage of the cargo and having capacity in the more recent installations for picking up 17 tons of ore per trip. This type of unloader is virtually a special form of hoisting tower and can be used either for unloading direct to cars or in conjunction with a stocking and reclaiming bridge.

With the introduction, by Mason in 1900 and later by others after the development of the Hulett unloader, of the compound lever system in the design of the clamshell bucket, which greatly increased its digging power and consequently its capacity in the handling of coal and made its use possible in the handling of iron ore, the use of the clamshell bucket became general, and, together with the ad-

of inclined or vertical inner side walls, and by increasing the number of vessel hatches and spacing them on 12 ft. centres in place of the former 24 ft. spacing, thus bringing practically all of the cargo in this style of boats within the reach of the clams.

Various other special mechanical trimming and clean up devices are also employed, one of which is a man trolley having turn-table hoist for rotating the bucket for opening forward and aft, thereby increasing the percentage of cargo to be reached. Another trimming and clean-up device is a power shovel, which is lowered into the vessel hold for trimming the ore or coal to within reach of the clamshell.

A comparatively recent development is the clean-up bucket, which is a special clamshell grab bucket for use after the unloading of the bulk of the cargo by the regular unloading clam. This bucket is specially proportioned to give a long spread when opened and is made narrow enough to lower when closed through the vessel hatch for opening without rotating lengthwise of the vessel, thereby reaching all the cargo in the otherwise dead space under the deck between the hatches.

FIG. 9.—ROBINS' CONVEYING BELT CO.'S REVOLVING COAL STOCKING AND RECLAIMING BRIDGE. SHOWS INCLINED CONVEYOR FOR DELIVERING COAL TO BRIDGE, ALSO CONVEYOR ON BRIDGE FOR STOCKING COAL, WITH MAN TROLLEY AND [illegible] FOR RECLAIMING. STOCKING CAPACITY FROM 600 TO 700 TONS PER HOUR, AND RECLAIMING CAPACITY [illegible] TONS.

vantages offered by electric power, led to the extensive use of the man trolley equipped with clamshells of comparatively large and rapidly increasing capacity. This type of trolley has in the past 15 years largely superseded the rope trolley in general use prior to that time, and, with the improved clamshell bucket, has marked the second large advance in the method of handling ore, coal and other bulk materials.

With the introduction of the clamshell bucket for the unloading of coal and ore the problem of cleaning up the vessel hold required attention in order to reduce hand shovelling to a minimum. This is accomplished in various ways. In the Hulett unloader, the long reach of the specially constructed grab bucket was largely, though not wholly, effective toward this end, even in boats with holds as then constructed. Further improvements were made in the [illegible] vessels of hopper and side tank construction in which the storage space in the vessel hold is narrowed up by the introduction

Various forms of power-operated [illegible] have also been used to reduce hand shovelling in [illegible] ore and coal [illegible] for [illegible] piles in stocking and reclaiming. Scraper buckets have also been used to a limited extent for reclaiming from storage [illegible] space for proper operation.

A method, considerably used in the Eastern States for the storage of large quantities of anthracite coal, is the [illegible] storage system, in which conical piles are stocked by means of inclined flights or scraper conveyors, in which the [illegible] is [illegible] by means of a [illegible], the end of which is advanced up the conveyor [illegible] pile and coal discharged over the end of the [illegible]. The movement of this [illegible] is controlled by means of a power-operated drum hoisted at the foot of the conveyor.

In the loading of both bituminous and anthracite coal to box cars, box car loaders of various types are in general use.

giving dispatch in loading and avoiding the hand trimming of coal in the car. These loaders are of two general types, the first being that in which the loading and trimming device is projected into the car where it receives, trims and distributes the coal. This class comprises loaders having a cradle within which travels a pusher, both the cradle and pusher having reciprocating motion lengthwise of the car; loaders having pan or belt conveyor for receiving and distributing coal; loaders having a circular drum for receiving coal within which are curved rotating blades for distributing coal. Box car loaders of this type may be stationary, portable for travelling by power, or mounted on sills of hoisting towers or bridges, forming an essential part of the unit on which they are mounted. The second type is a loader having a tilting cradle, to which the car to be loaded is clamped and tilted endwise sufficiently to insure the coal being properly distributed in the car by gravity. This type of loader is stationary and is used where it is desired to load large tonnage at a single point. The coal may be loaded from one side of the loader or from both sides simultaneously, if desired. These loaders have a capacity of 3,000 tons per 10-hour day.

Rope-car haulage systems are extensively used at both coal and ore docks and yards for the movement and spotting of empty and loaded railroad cars to facilitate loading. Portable box-car loaders are also used effectively for this purpose. There are also used to a very limited extent, specially designed locomotive pushers or poling locomotives, which are built sufficiently narrow to clear and to operate between cars on two adjacent railroad tracks.

Coal Mining.

With reference to methods of mining coal in the United States, it seems hardly necessary to more than state that there has been, within the past few years a marked increase in the percentage of coal mined by machinery, which approximately doubled within the 12 years prior to 1916, and which is a large factor in increasing the output of the mines. The self-propelling longwall, shortwall and arcwall mining machines and electrically operated drills, adapted to drilling and cutting at various heights, are used extensively. A power shovel for loading of coal to cars at the end of headings in mines has also been developed practically, eliminating the need of hand shovelling where used. The gathering locomotives are of storage battery and cable reel types, while the electric trolley type is used for hauling. The increasing use of horizontal shaking screens and picking tables, mechanical loading booms, washing jigs, and spirals for removing impurities facilitates the preparation of the coal and reduce breakage and waste.

The production of bituminous coal for 1916 was 496,557,405 net tons and of anthracite 87,815,163 net tons, making a total of about 585,000 000 tons. The estimated tonnage of bituminous coal for 1917 is about 700,000,000 net tons or 20 times that produced in 1877.

The heavy coal traffic from the mines to lake and ocean ports requires powerful locomotives and cars of large capacity. To meet this need the Norfolk & Western Railway has for several years had in regular service a large number of steel cars of 90 tons nominal and of 100 tons actual carrying capacity. These cars have three axle articulated trucks to avoid high wheel loads. The Virginian Railway, during the present year, has built several still larger experimental gondola coal cars of 120 tons actual carrying capacity. These cars weigh 73,900 lb. and have coupled length of 53 ft. 7 in. A 422-ton Baldwin locomotive, the largest thus far built, is also operating on the line last named. This locomotive is of triple articulated type, having 2–8–8–8–4 wheel arrangement, with total wheel base of 91 ft. 3 in., and has three sets of cylinders and driving wheels, one set being located under the tender. The maximum tractive effort of this engine is 166,300 lb.

Coal-Handling Plant.

The transfer of coal from railroad cars to vessels at ports of the lower Great Lakes has, for a period of over 25 years, been accomplished by the use of coal car dumpers. In more recent years, car dumpers have been employed on the Atlantic seaboard, where they are used both for loading coal direct to vessels, as on the Lakes, and at coal loading piers where elevated pockets and various types of auxiliary mechanical equipment are also used. Car dumpers are of several general types, but the essential operation in each is the overturning of gondola cars for discharging their contents to vessels. In the modern type of dumpers, the car is run on to and clamped to a cradle, which is revolved through about 135°, and the coal is dumped on to an apron where it is concentrated and delivered through a chute to the vessel hold. In some instances the car is hoisted before being overturned, and in other cases it is overturned without being hoisted, the coal being emptied into a bin, which is then hoisted and its contents dumped on to an apron or chute for delivering to the boat, as above described. Cars are ordinarily delivered by a gravity track from the empties yard to a kick back on the car dumper track and then hauled to the car dumper cradle by means of a barney or dummy car operated by rope haulage. The breakage of the coal is reduced to a minimum in being discharged to the vessel by the use of telescopic chutes with valve or gate at the

Fig. 10.—Western Fuel Plant, composed of 2 5-ton Rope Trolley Bridges, having Belt Conveyors for Stocking on Dock and for Filling Loading Hoppers. View shows Bridges in Alignment and Conveyors on No. 1 Bridge Discharging into Conveyor on No. 2 Bridge, Clarkson Coal and Dock Co.'s Dock, Duluth, Minnesota (The right hand end is not fully shown).

lower end. Car dumpers are ordinarily, in whole or in part, electrically operated, steam being considered advantageous for certain operations.

With these car dumpers, seven cars have been dumped in 6 minutes and 90 cars in 95 minutes. In a recent installation the guaranteed capacity was 40 [illegible] and 50 [illegible] cars per hour, the actual working cycle being 49 seconds. In the unloading of coal the self-unloading vessel leads with a capacity of 2,000 tons per hour. In the unloading of vessels by man trolleys, where the usual number of hoists or bridges are operated on a single boat, the cargo is discharged at times at the rate of 1,000 tons per hour. As much as 7,000 tons of bituminous coal has been unloaded in 10 hours actual working time by man trolley, equipped with 12-ton clamshell grab bucket, on a single Heyl & Patterson bridge installed in 1913 on the North Western Fuel Co.'s Dock No. 1, Superior, Wisconsin.

SEABOARD PLANTS.

The above description of ore and coal handling equipment applies principally to that used on the Great Lakes, where it was first developed and where for many years advanced methods of handling have been in extensive use. These methods were promptly adopted at the blast furnace ore yards, and in recent years this type of equipment has come into general use on the Atlantic seaboard and wherever throughout the country despatch is required in the handling of large tonnage of bulk material.

One of the earlier modern type vessel coal loading piers on the Atlantic seaboard is that constructed in [illegible] by the Norfolk & Western Railway Co. at Lamberts Point, Norfolk Harbour, Virginia. One of the essential requirements in designing this pier was the delivery, on short notice and with despatch, of a large tonnage of one or more of many kinds and sizes of coal to a boat of any size or kind. This plant comprises a pier 90 ft. wide by 1,200 ft. long, containing 64 115-ton self-clearing vessel-loading pier hoppers and served by two 100-ton car dumpers delivering coal to [illegible]-ton electrically propelled pier cars and two 30-ft. electric elevators for hauling the pier cars to top of the pier. These cars are fitted with bottom doors operated by compressed air. This pier has a rated maximum hourly capacity of [illegible] tons, any part of which may be delivered to a single vessel. The terminal yard supplying coal to this pier has over 50 miles of yard tracks, sufficient for holding 3,300 cars.

The plant of the Pennsylvania Road at Canton, Maryland, while not intended especially for large capacity, possesses the flexibility required in serving vessels and boats of all kinds for the local and coastwise trade. The distinctive features of this plant are a car dumper, delivering coal to 4-ton cable cars, which are hauled up an incline to the trestle where coal is delivered to three loading towers and to ten 75-ton capacity storage bunkers. The loading towers are of various sizes and designed to suit the sizes of vessels to be served. The largest tower is equipped with pan loading conveyor on movable arm, making it possible to either elevate or lower coal under control in delivering it to vessels of various heights and as high as 56 ft. above water. The other two towers deliver coal by gravity chutes. The 10 coal bunkers are served by a weighing loader, which is provided with a conveyor for discharging to vessel. The plant has a capacity of 1,500 tons per hour, which can be doubled by increasing the number of cable cars.

A vessel-loading coal-pier put into operation during the present year by the Baltimore & Ohio Railroad at Curtis Bay, Baltimore Harbour, Maryland, has a rated capacity for handling 12,000,000 tons of coal per year, a larger capacity than any pier

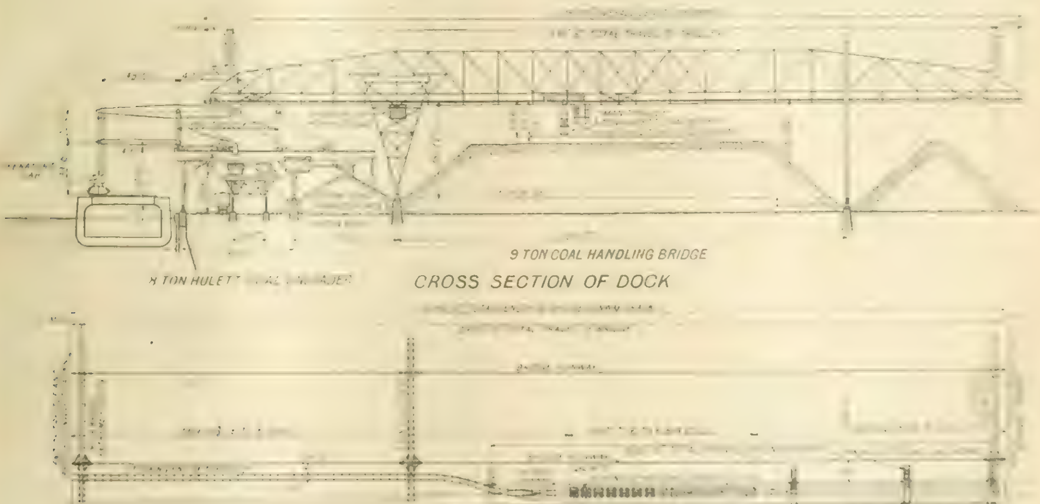


FIG. 11.—GENERAL ARRANGEMENT OF NEW [illegible] DOCK.

previously constructed. This pier, in its general arrangement and in some of its individual features, is a departure from the usual construction. This plant is designed not only for great capacity, but for flexibility required in the [illegible] loading of the largest [illegible] simultaneously with the loading of all kinds of smaller water craft. The characteristic features of this installation are:—

A reinforced concrete loading pier [illegible] ft. wide by [illegible] ft. long.

Two McMyler car dumpers with [illegible] located at inner end of pier.

Four McMyler [illegible] towers equipped with [illegible] conveyors [illegible] on either side of the pier [illegible].

Two travelling [illegible] towers equipped with boom conveyors capable of swinging through 180° and [illegible] from the horizontal, the purpose of these being the [illegible] and [illegible] the boat while the cargo is being loaded.

Two Robins 48 in. trimmer and four 60-in. main loading belt conveyors extending along the pier, delivering coal to the trimmer cranes and loading towers, respectively.

Three short feeder belt conveyors, two feeding the 60-in. main loading belts and the third delivering coal to an inclined conveyor, which is pivotted for swinging horizontally for discharging to the balancing bin.

A storage bin designated as a balancing bin, having eight trimming and storage hoppers of 5,000 tons aggregate capacity,

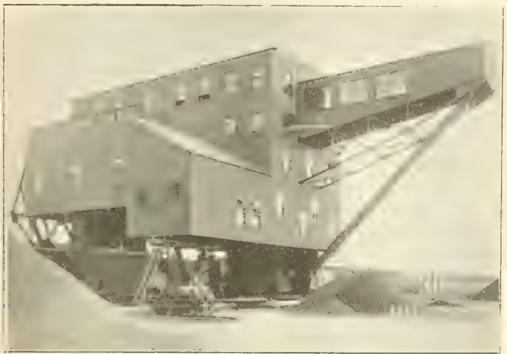


FIG. 12.—LINK BELT CO.'S DETACHED TRAVERSING BITUMINOUS SCREENING PLANT, BERWIND FUEL CO.'S DOCK, DULUTH, MINN.

of which the function is to permit continuous operation of the car dumpers while the main loading belts are idle, incident to the moving of the loading towers, and also to permit the operation of the two main loading belts while the car dumpers are idle. The 48-in. trimmer conveyors receive their coal from the balancing bin, as also do two of the 60-in. main loading conveyors, when desired.

FIG. 13.—[illegible]

The total capacity of the pier is [illegible],000 tons per hour and a single unit will load a 7,000-ton vessel in 3 to 3½ hours with 12 men. The plant is of the type known as the Stuart system of vessel loading, now controlled by the International Conveyor Corporation.

The Ohio and Mississippi Rivers and their tributaries offer cheap transportation of coal by tow barges, especially for shipment down stream and where the railroad haul from mine to shipping point on the river is not too great. Coal is thus shipped from Pittsburg and lower points down the Ohio and Mississippi Rivers.

During August of the current year the first coal to be brought by tow barges to St. Paul, Minnesota, at the head of navigation on the Mississippi River, was a cargo of approximately 3,500 tons of Illinois coal, shipped from St. Louis, Missouri, by a fleet of five barges, which made the return trip to St. Louis loaded with 4,200 gross tons of iron ore from the Cuyuna Range, Minnesota, thus extending this method of exchange of products to a section of the Mississippi River where it had not been previously employed, and indicating the possibility of future development on a commercial scale. For the purpose of the initial trip the bridge of the St. Paul Bridge & Terminal Railway Co. was made to serve as an improvised ore dock, the ore being transferred from hopper bottom railroad cars by gravity direct to the barges through openings in the bridge floor made by cutting away a portion of the railroad ties between rails. The operation of loading ore at the bridge was sufficiently satisfactory to warrant its continuance in service in the

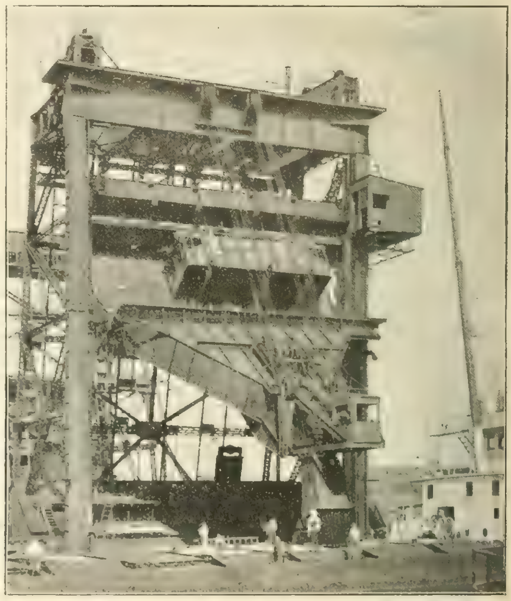


FIG. 14. BROWNHOIST CAR DUMPER FOR TRANSFERRING COAL FROM RAILROAD CARS TO GREAT LAKES AND OCEAN-GOING VESSELS.

capacity mentioned, single 63-ton cars being unloaded in $1\frac{3}{4}$ minutes.

Development during the past few years, in both equipment and methods, has been rapid and still continues. Radical departures in general design are not infrequent, and important modifications in detail are made with successive installations to suit individual requirements, even where the general design remains the same. Although the recent progress in the methods of handling material has been marked, it would not be surprising if the advance in the near future along this line were even more pronounced.

The writer wishes to express his appreciation of the courtesy of the management of the various dock, mining and manufacturing companies in co-operating with him in furnishing photographs and data for use in the preparation of this article.*

* Unfortunately we are prevented by lack of space, and the present abnormal conditions, from reproducing more than a very few of the extremely interesting collection of photographs sent by the author.—ED. E.

Belt Shipping Plants.

By F. G. MITCHELL.

Summary.—Attention is drawn to the great advantages of the belt conveyor for the shipment of coal and ore in bulk. This plant is not limited by mechanical difficulties; and any disadvantages do not increase, but rather the reverse, as the output is increased. A detailed account is given of an interesting plant of this type at Durban.

During recent years the belt conveyor has been rapidly developed for the shipment of coal and ore in bulk. The chief reason this type of conveyor has developed in preference to the other methods of shipment is that its capacity is unlimited by any mechanical difficulties, and it is always possible to produce a plant which will ship at the highest rate the boats can receive the material shipped.

Fig. 1.—Car Dumper and Concentrating Pan.

Another advantage of the belt type of conveyor is that its increased capacity is not attended by any increase in disadvantages, but rather the reverse, as it is found in practice that it is certainly easier to load to a belt at 1,000 tons per hour than at 100 tons per hour, and if the material to be handled is large in size the greater the capacity the less difficulties there are.

Once the material is on the belt it is carried without movement and discharged through the chute or hopper to the ship's hold.

The only difficulty in connection with such plants is getting the coal or ore on to the belt freely, and at the rate required. It will be readily understood that for the larger capacities openings have to be provided in the feeding hoppers of correspondingly increased size, which in turn allows a freer flow of material and greatly reduces the difficulties of handling at the higher rates.

The actual efficiency of the higher capacity plants is greater from the power point of view, while the cost for labour per ton handled is reduced almost in inverse proportion to the quantity shipped, as the same number of attendants are required for a belt carrying 100 tons per hour as are required for a belt carrying 1,000 tons per hour. It will be seen, therefore, that the development of the belt conveyor is not unnatural, as it is certainly the one device which improves in all respects by having its capacity increased.

In these days when shipping is of so very much increased value, and when a saving of many hours is obtained by means of a fast plant, it will be seen that the economy does not stop with the machine itself, but extends to the actual shipping cost, and, indeed, under the present circumstances, becomes almost of national importance, as the introduction of one fast shipping plant will, in the course of a year, allow any one boat to make several extra trips, which when multiplied by the number of boats actually loaded would be equal in value, as far as the country is concerned, to several extra boats.

This is a point of view which certainly should not be overlooked under the existing conditions. It is a point which should receive careful attention, and where time is wasted in loading or unloading ships the possibility of introducing a machine for turning the boat round more readily should be carefully considered.

We illustrate one or two of the higher capacity shipping plants which are in use in different parts of the world, and we propose to give a detailed description of one of the more recent plants which has been lately installed at Durban, South Africa.

The plant at Durban is for the shipment of export coal and is also arranged for bunkering [illegible] South Africa.

Fig. 2.—[illegible]

The coal at Durban is brought down from the mines in various sized trucks up to a maximum of 70 tons of coal per truck. The trucks are stored in a series of sidings representing the coal from various collieries.

When a ship comes alongside to coal, the trucks from these various sidings have to be run down to the tippler and there discharged, and when empty passed on to the empty sidings. The coal is fed from the tippler to the belts, and carried by them to the steamer.

It will immediately be seen that, apart from the main mechanical details of such a plant which have to be perfectly designed to enable the whole to work successfully, it is of the utmost importance to have the sidings and the dumper so arranged that there is no loss of time in bringing the full engages with the truck and propels it to the cradle of the dumper. Directly the truck is on the dumper the pig returns by gravity to its pit awaiting the next truck.

The truck on the cradle is dumped, and when empty runs down again by gravity to the marshalling sidings for the empties, which are at the same level as the original full truck sidings.

The pig, therefore, not only feeds the dumper with wagons, but also elevates them sufficiently to allow the incline necessary both for running the full trucks to the dumper and the empty trucks away from the dumper.

The cradle of the dumper is capable of taking one 75 ton wagon or two smaller wagons side by side. Directly the wagon is deposited on the cradle the cradle is elevated to the

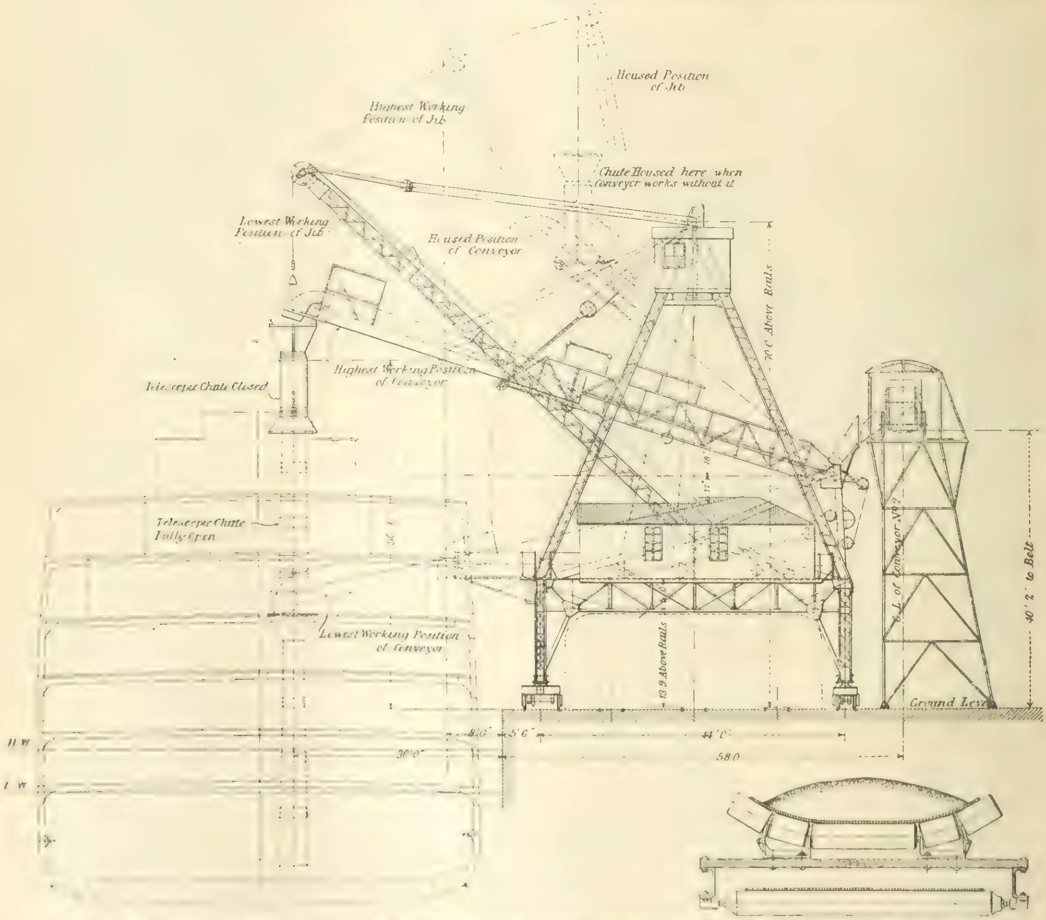


Fig. 3.—Diagrammatic Arrangement of Travelling Tower, showing Variations in Level and Position of Discharge.

wagons up and taking the empty wagons away, and also arranged so that wherever the boat is placed along the quay the coal can be discharged to any hold as and where desired without any loss of time.

The arrangement of the sidings is such that the full trucks can be let down over the points on to a "kick back" by gravity, the "kick back" allowing the truck to come to rest immediately in front of the pig. The pig is a truck arranged on a narrow gauge track, which is depressed at a point behind where the truck comes to rest, so that the pig can go down below the ground level and the truck pass over it. Directly the truck is in position the pig is hauled up from its pit and desired level, and then revolved so that the whole contents of the truck is delivered into the large concentrating pan or receiving hopper, from which it is fed to the inclined conveyor.

Fig. 2 is a general view and shows the loaded trucks waiting to be fed to the dumper. The "kick back" is in the foreground and leads down to the incline up which the trucks are hauled by the pig to the dumper.

Fig. 4, "Car Dumper and Concentrating Pan," shows a 75-ton truck on the cradle, which has just commenced to rise preparatory to revolving and discharging the contents of the truck into the concentrating pan. This illustration is a photograph taken looking up the incline and shows the pig track.

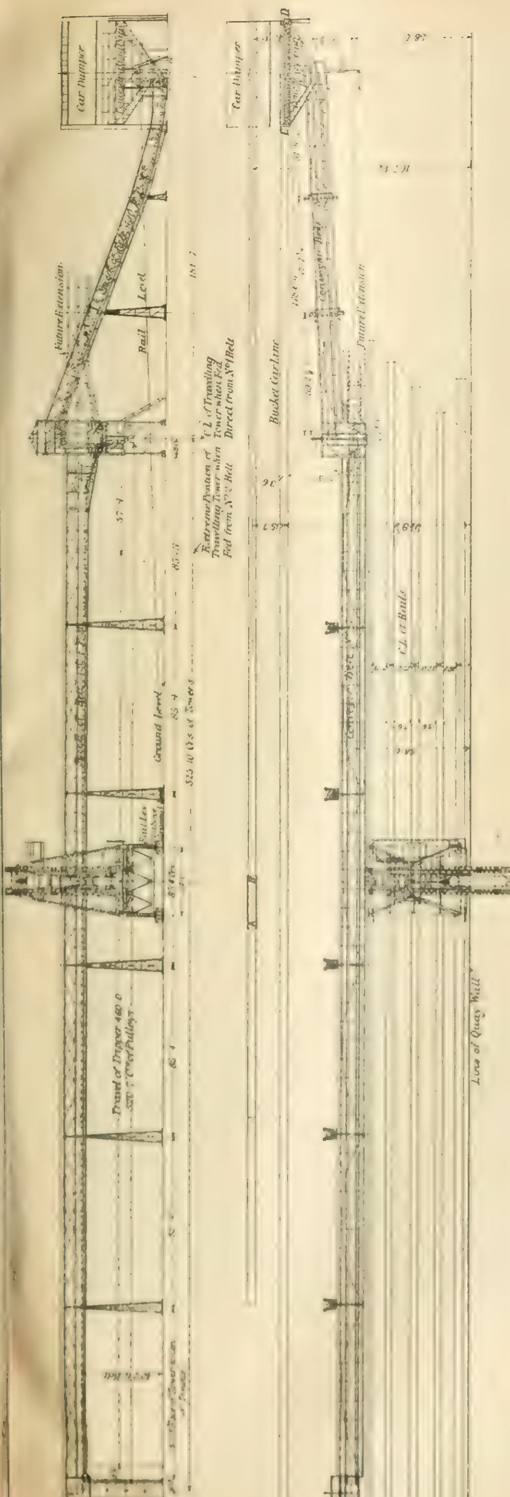


FIG. 4.—GENERAL ARRANGEMENT OF PLANT.

The main hoisting and controlling machinery is situated in the house over the track, while the winch operating the pig is in a house under the track. The cradle which carries the truck is so arranged that directly it is raised from the rail level the truck is automatically clamped, so that it cannot move or be released when the cradle is revolved. The clamping is effected by a series of counterweights, which move the track

FIG. 5.—ORE SHIPPING PLANT: CAPACITY 600 TONS PER [illegible]

and the truck bodily sideways until the side of the truck bears against a series of timber supports, on which it rests while being revolved.

In addition to these timber supports the counterweighted clamps are allowed to rest on top of the truck, which prevents same leaving the rails when in an inverted position. On the

FIG. 6.—ORE SHIPPING PLANT [illegible]

return of the rail to its original position the truck is automatically replaced in its original position and the clamps removed, so that there is no hand manipulation required in any way for the clamping of the trucks, [illegible] giving that clamping and unclamping is effected automatically by the movement of the cradle itself.

The movements of the cradle are controlled by three 150 H.P. motors, each controlled by means of contactor type controllers.

After leaving the concentrating pan the coal is carried by a 48 in. belt, travelling with a maximum speed of 430 ft. per minute, to a distributing tower, which discharges the coal either to a tripper belt or direct to the travelling tower, or to chutes which are provided for future extensions of the tripper belt, which will eventually be erected running in the opposite direction to the conveyor shown in the illustration.

The coal is discharged either direct or by means of the travelling tripper to the travelling tower, by which it is delivered from the tripper.

The travelling tower is provided with a hinged telescopic 48 in. conveyor, which is capable of depositing the coal at any height up to a maximum of 50 ft. above the rail level and at varying distances from 8 ft. to 30 ft. from the edge of the quay.

The conveyor can discharge direct to the hatchways of the vessel at any state of the tide, or can discharge to the hold by means of a telescopic anti-breakage chute, shown on the diagram.

The capacity of the plant varies from about 100 to 1,000 tons per hour, at the will of the driver, who is capable of varying the amount discharged according to the capacity of the steamer for receiving the load of coal.

The travelling tower is so designed that the whole of the conveyor and the telescopic chute can be hoisted in clear of the quay, and the telescopic chute can be used or not, as desired, and also can be dismantled from the machine while loading is proceeding without interfering with the other movements of the tower. All the idlers on the plant are of the ball bearing type, the rollers being made of steel.

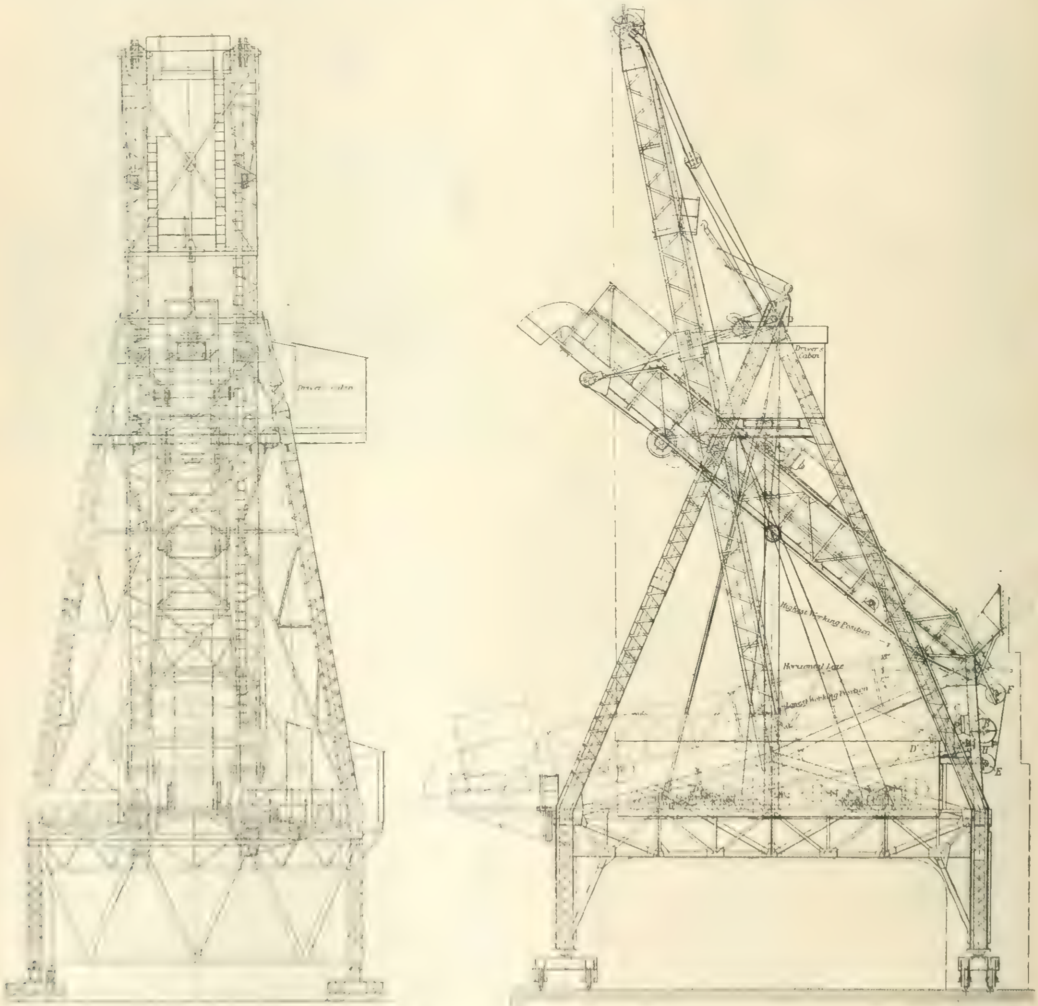


Fig. [illegible].—Design of Travelling Tower.

One of the main features of the plant is the system of control. The whole of the plant, including the three conveyors, telescopic and luffing motions of the telescopic conveyor, all the various motions of the telescopic chute, and the travelling of the tower itself, are under the control of one driver, who is placed in a cabin at the highest point of the tower, from which he gets a clear view of the whole plant.

The variation in capacity is provided by allowing the belts to run at varying speeds, according to the capacity required. This is also under the control of the one driver, who is provided with a master controller, which operates the contactor panels

of the main controllers at the driving end of the various conveyors.

The electrical gear is also provided with automatic cut-outs, which entirely prevent any possibility of mistakes being made, *i.e.*, the tripper belt cannot work unless the telescopic belt is already running, while the inclined conveyor cannot be started up until both the telescopic and the tripper belts are running. The stopping down is done in the reverse order, *i.e.*, it is impossible to stop the telescopic belt until the tripper belt is stopped, and it is impossible to stop the tripper belt until the inclined belt is stationary.

This makes it impossible for coal to be piled up at any point, and a jam caused in any of the transverse chutes, which has, on some previous plants installed, been a considerable source of danger.

All the telescopic and luffing movements of the chute are provided with cut-out switches, which immediately stop their respective motors and prevent any overwinding, while if the current fails for any reason on any part of the machine the whole plant is arrested by solenoid brakes until the current is again switched on.

A push-button control is also provided at every point on the plant where it is possible that a jam or an accident could occur, such as at the tripper, all transverse chutes and all driving pulleys, and also at many intermediate positions.

These push-buttons are provided so that should any attendant or engineer observe anything irregular occurring he can immediately stop the whole plant by simply pressing the button which is provided.

By the introduction of such safety devices it is believed that the whole plant is as near foolproof as possible, and also amply safeguarded against any accident or mistake, while it is also under the complete control of one man, and, moreover, cannot be controlled by more than one man, so that the loss of time due to the necessity of signalling when more than one driver is used is entirely obviated.

In addition to the concentrated control of the whole plant, all motions are provided with large size motors and each is given a speed control so that when everything is clear the movements can be performed very rapidly and very little time lost in moving from one hold of the steamer to another.

The jib and conveyor can be telescoped and the whole tower run along and the conveyor again put in position to a fresh hold, with a minimum loss of time.

The motors controlling the inclined and the cross horizontal belt are each of 80 H.P. continuous rating. The motor driving the telescopic conveyor is of 35 H.P. and the motor controlling the telescopic movement 15 H.P. The motor traversing the whole tower is of 45 H.P., while the other motors in connection with luffing and telescoping the chute are of 15 H.P. each, and all capable of giving 100 per cent. overload for the short period that they are called upon to work.

In actual operation the plant fulfils all the expectations of its design; and it is found that the driver has very complete control over all the parts and that the various movements and operations can be carried out simultaneously without difficulty.

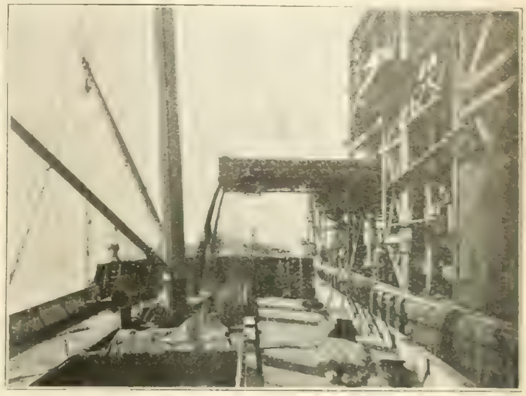


FIG. 8.—ORE SHIPPING PLANT—CAPACITY 1,500 TONS PER HOUR.

The plant and layout of same was designed by Mr. A. M. Tippett, chief engineer to the South African Railway, while Mr. G. Thomson, a member of Mr. Tippett's engineering staff, came to England to superintend the construction. The plant was officially opened by Sir Thomas Hyslop and Sir Wm. Hoy on Feb. [illegible], 1917, in the presence of a large gathering of merchants and representatives of all the shipping, trade and engineering establishments of South Africa.

The plant was manufactured by [illegible], Ltd., of Leith. The drawings are reproduced through the courtesy of "Engineering."

FIG. 9.—COAL SHIPPING PLANT—CAPACITY [illegible] TONS PER HOUR.

The Equipment of Railway Goods Stations with Electrical Machinery for Dealing with General Merchandise.

By ROGER T. SMITH, B.Sc.
(Electrical Engineer of the Great Western Railway.)

Summary.—The business of collection, delivery and handling of goods by railway companies has been built up in the last three quarters of a century to suit the trader. In goods stations mechanical apparatus has been introduced either for the sake of economy in labour or to deal with weights beyond manual capacity. Nevertheless, in a fully-equipped station, the percentage of merchandise handled by machinery is small. Modern methods permit the machinery to be brought to the load, instead of *vice versa*, and in this development electricity has proved superior to other forms of power. Examples of goods-handling machinery are given, being taken from four modern goods stations or yards on the Great Western Railway, and include cranes, capstans, lifts, traversers and conveyors.

General Considerations.

THE business of a railway is to sell transport, and for a railway serving important industrial and agricultural districts the transport of goods, as opposed to the transport of passengers, is generally the most valuable commodity which it has to sell.

So far as goods traffic is concerned, British railways are "common carriers," and with certain specified exceptions are bound to receive and carry the goods of any trader, providing railway wagons and charging a rate which may or may not include collection at the sending station from the consignor and delivery at the receiving station to the consignee. For certain classes of goods, such as coal, coke, grain, sand, and charged from station to station only, at rates which do not include collection and delivery, can be delivered and loaded by the consignor and unloaded and collected by the consignee. A goods station may further include, in addition to offices for its clerical staff, cattle pens, stables, or garages for road vehicles, but these items have no concern for us here. Figs. 1, 2, 3 and 4 show plans of three typical modern goods stations.

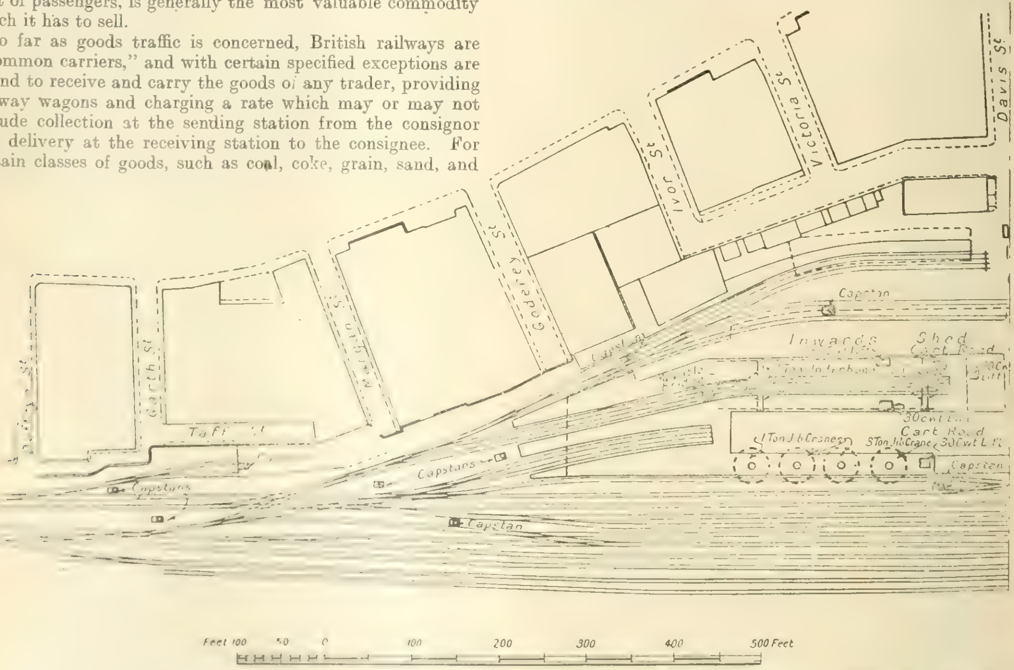


Fig. 1.—Plan of Sheds and Yard of

[illegible] railways are not generally common carriers, but only haul from point to point in wagons owned by the traders, although some railways provide wagons for coal and coke.

A goods station (which is the term used to include the station buildings and the open goods yard) comprises a covered shed or sheds with roads and platforms where the bulk of the merchandise traffic collected and delivered by the railway's own road vehicles, by agents on their behalf or by the traders themselves, is loaded and unloaded. Often a goods station also comprises a warehouse or cellarage or both for the storage of goods, and ramps for dealing with furniture vans, showmen's vans and similar wheeled traffic.

The goods yard usually also contains sidings not accessible to road vehicles where wagons can stand ready to go forward or be marshalled in their correct order into trains, either to enter the goods shed for unloading or to leave the station loaded. The goods yard contains sidings accessible to road vehicles where the special and often heavy "mileage" traffic, usually

At small stations both passenger and goods traffic can be handled by the stationmaster, the work being done under his personal supervision. Where the goods station is large enough to make such supervision impossible, an organisation is required under separate control. The controller for moderate sized stations is called a goods agent, while stations of the first importance are the headquarters of a goods superintendent who in addition, not infrequently has one, two or more depots under his supervision.

In normal times the energies of the chief officer of a goods station are directed to secure for the railway the greatest amount of traffic, both inwards and outwards, with which his station and depots can deal, generally in competition with other railways.

The equipment of a goods station is determined chiefly from this point of view, traffic having a habit of following

facilities. If a goods station, in competition with that of another railway, has no facilities for dealing with very occasional heavy loads from a trader, the bulk of his traffic has a tendency to go to the station which can load everything, large and small. The quantity of heavy loads in a district—boilers, girders, or heavy forgings—may not seem to justify the instalment of a 30 ton gantry or goliath crane, but its presence may bring incidentally a large traffic of merchandise which would otherwise be lost to the railway.

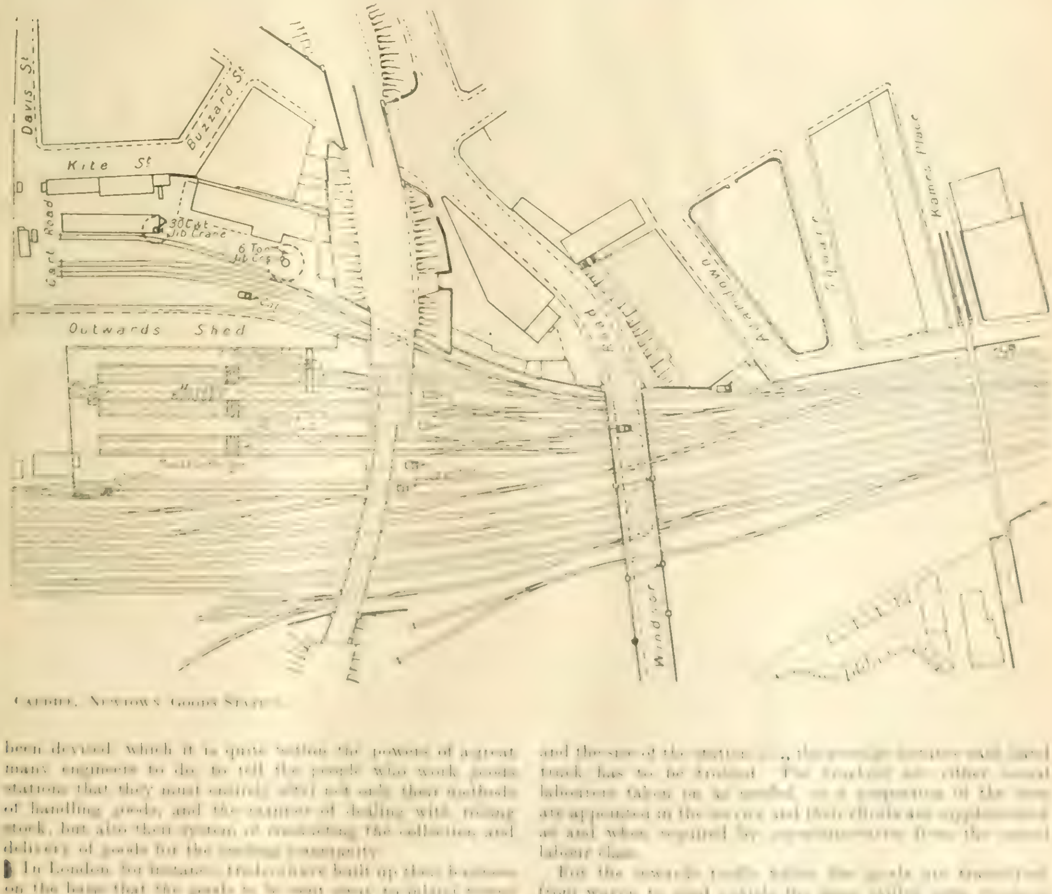
The equipment of a goods station with mechanical appliances for handling goods is essentially a commercial problem. No two goods stations are alike, and each station should be considered solely from the point of view of the traffic it has, or may have, to deal with, both general and special. This is a platitude which it would hardly seem necessary to state were there not a tendency in some quarters to consider that it is the function of the engineer to design elaborate apparatus to handle all goods mechanically, and when such a system has been devised which it is quite within the powers of a great many engineers to do, to tell the people who work goods stations that they must entirely alter not only their methods of handling goods, and the manner of dealing with rolling stock, but also their system of conducting the collection and delivery of goods for the trading community.

In London, for instance, traders have built up their business on the basis that the goods to be sent away to distant towns should be collected by road vehicles during the afternoon and early evening, there being a "peak" in the flow of traffic between 4 and 6 o'clock in the afternoon for goods conveyed by the public. The company's own vehicles collect [illegible] up to about 6 p.m., and according to the geographical position of the station there is another [illegible] peak in the flow of traffic between 7 p.m. and 9 p.m., which then slows down but continues till nearly midnight. The goods may include anything from a basket of [illegible] to a [illegible] of glass or a summerhouse.

The unloading of road vehicles and conveyance of the goods to the wagons for the outwards traffic is carried out by gangs of men, [illegible] consisting of a checker and a caller-off, the latter calling the particulars of the goods to the former as they are unloaded by the trucker or porter. The checker compares and corrects or amplifies the actual particulars, as called, with those in the consignment note. Unless a special unloader is provided, the trucker, assisted by the carman, unloads the road vehicle on to the platform, passing the goods over the weighing machine when necessary, packs the maximum quantity which can go on to a hand barrow or trolly, and wheels it to the wagon into which a stower or loader packs the goods brought by the trucker. Each gang for transferring goods from road to wagon consists essentially of a checker, who is in charge, a caller-off and a loader, all of them skilled men and appointed to the staff. The rest of the gang is made up of two, three, four, or even five truckers according to the character of the goods to be loaded and the size of the [illegible], the average [illegible] hand truck has to be trucked. The truckers are either casual labourers taken on as needed, or a proportion of the men are appointed to the staff and their efforts are supplemented as and when required by [illegible] from the casual labour class.

For the inwards traffic, where the goods are transferred from wagon to road vehicle the same skilled men, checkers and callers-off, are employed in unloading the wagon, assisted by the truckers or porters. The unloading of [illegible] and their dispatch to the [illegible] begins as early as [illegible] or even earlier, and this activity [illegible]. The delivery of goods goes on all the morning, but the [illegible] is more evenly distributed than for the outwards goods, still there are generally two peaks in the flow of inwards traffic.

For dealing with general goods at the present time, there [illegible], without appliances [illegible] usually work



CARDIFF, NEWTOWN GOODS STATION.

on a bonus system. For each gang an average minimum weight handled per day or per week is fixed, and upon all weights in excess of the standard fixed a bonus of so much per ton is paid for that excess weight. On this system some part of the increasing tonnage in recent years has been dealt with satisfactorily both to the men and the railway.

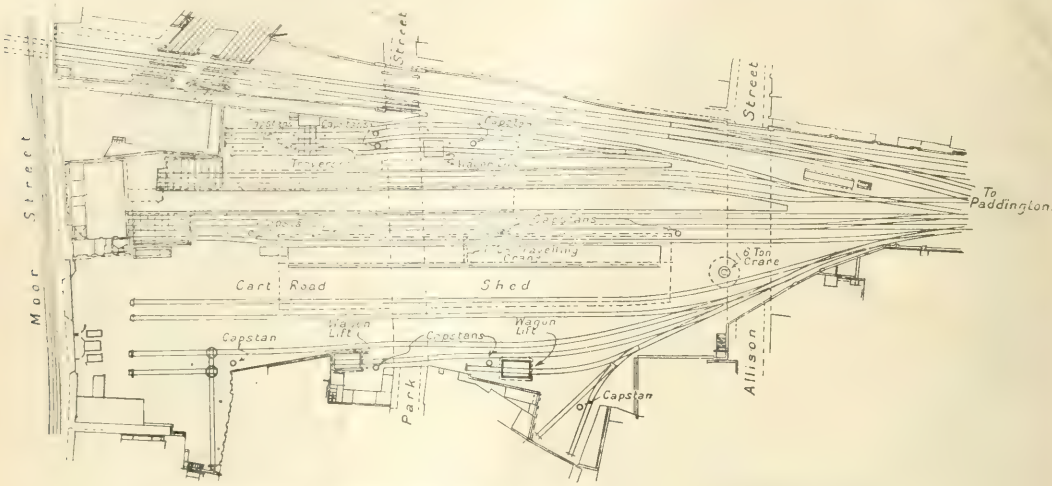


Fig. 2.—Plan of High-level Yard and Shed at Moor Street Goods Station, Birmingham.

For yard traffic, when it is regular and continuous, piecework or tonnage rates can be fixed and are quite satisfactory, but they are not satisfactory for the varying work of general goods handling, although here again the practice varies in the different railways to meet local conditions.

On different railways and in different stations of the same railway the above outline of the conditions of manual working may be varied, and it is not intended or necessary to describe more than the average conditions of many large goods stations, but an understanding of the usual methods of handling goods is necessary as a starting point when considering the mechanical equipment of a large goods station.

Starting therefore from the basis that the handling of general and special merchandise in a goods station has been rightly built up to meet the methods developed by traders all over the country during three quarters of a century, a goods station may be equipped mechanically for two reasons:—

I. Mechanical apparatus may be provided with the idea of economy in saving manual labour and in saving time, as well as for dealing with weights which cannot be dealt with by hand.

II. Mechanical apparatus may be provided solely for dealing with weights of merchandise which cannot be dealt with by hand, or for raising and lowering goods (whether light or heavy) into or out of a warehouse.

It is to be noted that the handling of the goods themselves is here alone considered. To enable railway wagons to be loaded or unloaded mechanical appliances such as wagon lifts, wagon traversers, turntables and capstans may be essential or desirable for moving the wagons themselves, either loaded or empty, as opposed to the moving of the goods in them.

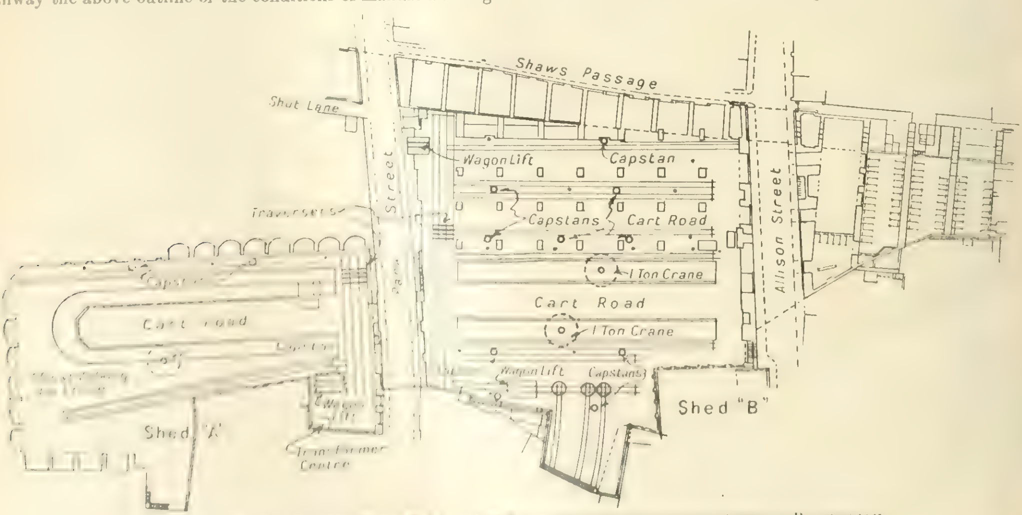


Fig. 3.—Plan of Low-level Sheds "A" and "B" at Moor Street Goods Station, Birmingham.

The ground floor of the goods shed consists alternately of rails for wagons and of platforms from which or on to which the goods are loaded or unloaded. All goods that can be so carried are wheeled by the truckers on hand trucks or lorries between the platforms beside the rails and the platforms against which the road vehicles are stabled.

Any mechanical means for doing this work, by conveyor, by overhead cranes, or by overhead runway, will only save a certain percentage of the truckers. Of the unit gang already described the checker, the caller-off and the stower would still be essential and in addition an unloader is required. Any mechanical system will need at least two truckers, or their equivalent, for feeding the conveyor, or crane, or runway, and for receiving the goods at the other end. A small saving in unskilled labour may result, but although in remodelling existing goods sheds or designing new ones mechanical transport has been again and again designed, and in some few cases partially applied, so far as the author is aware no case has ever been successfully made out for the handling of general merchandise wholly by mechanical means.

MOTIVE POWER FOR MECHANICAL EQUIPMENT OF GOODS STATIONS.

Before railway goods traffic had been developed to its present vast dimensions, such mechanical appliances as were used for handling heavy goods consisted almost entirely of the slewing jib crane, fixed on the goods shed platform, so as to command both railway wagon and cart road. Every wagon and every car to be loaded or unloaded had to be brought to the crane either by the shunting locomotive, the capstan, or the horse. The modern system of goods working is to bring the loading or unloading machinery to the wagon and to the road vehicle and so avoid the expense and waste of time in shunting wagons.

As the volume and weight of loads increased, hand jib cranes were superseded by hydraulic jib cranes, and the other power machinery consisted almost exclusively of hydraulic capstans and lifts, either for wagons or goods.

With the exception of two or three towns in this country hydraulic power cannot be bought, and the cost of working a pumping plant for a small and intermittent 24-hour load is

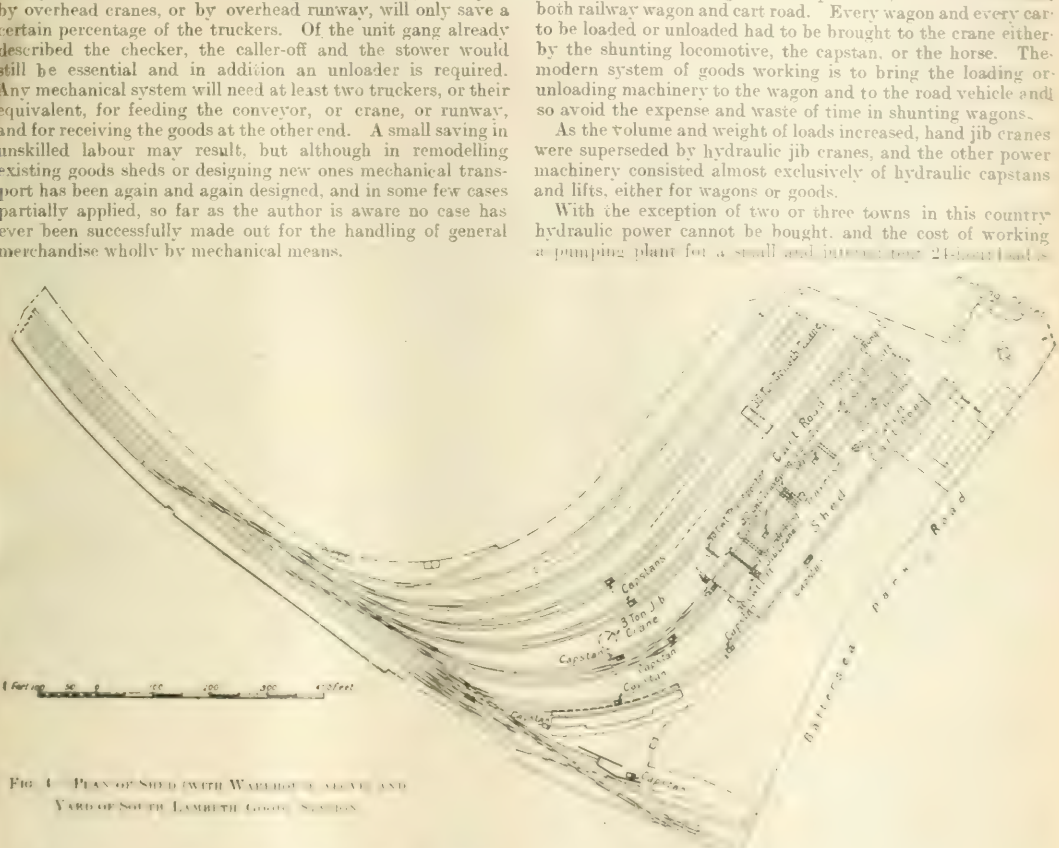


FIG. 4.—PLAN OF SHED (WITH WAREHOUSE ABOVE) AND YARD OF SOUTH LAMBETH GOODS STATION.

As opposed to general merchandise handling, the case of dealing with one class of goods or a few classes of goods of approximately similar size and weight is quite a different matter, and in such instances mechanical handling, including wagon loading, is more successful and economical, especially when the goods do not arrive in bulk. As an instance, the plant used by the Lancashire and Yorkshire Railway in handling cotton is one admirable example.

Consideration will therefore be narrowed to condition II., in which mechanical handling of general goods at platform level is confined to such weights as cannot be dealt with by hand, and to the raising and lowering of goods to or from other levels for warehousing purposes.

The necessary mechanical working of wagons as opposed to goods will also be considered.

Careful measurements taken in a modern goods shed recently constructed for dealing with general merchandise and equipped with the most modern design of overhead travelling and traversing cranes commanding the whole shed and the cart road, and with lifts for transferring goods to and from the warehouse above the platforms, show that [illegible] per cent of the total goods dealt with are handled mechanically. It is doubtful if in any shed dealing with general merchandise more than 5 per cent. is moved by machinery.

considerable. For the jib crane and for the lift, hydraulic machinery is simple, inexpensive to install and cheap to maintain. It is less simple and satisfactory for the capstan since the motion is rotary, but so long as goods station machinery was confined to these three pieces of apparatus hydraulic power, if costly to generate for so small a work, was entirely satisfactory. When, however, [illegible] cranes, power traversers, [illegible] and conveyors became necessary, hydraulic power was [illegible] of the question as compared with electric power in the [illegible] of the [illegible]. With [illegible] electric power can also be bought and be used for lighting as well.

For modern goods stations it is [illegible] a [illegible] of [illegible] cranes and electrical machinery will be installed, [illegible] generating station [illegible] for lighting and power, and electrical machinery for the mechanical handling of goods is assumed in this paper.

It happens that within the last [illegible] years the author has been responsible, as electrical engineer of the Great Western Railway, for the electrical equipment of [illegible] goods [illegible] as well as for [illegible] other small yards or stations. These [illegible] to supply examples of most modern kinds of goods and wagon handling mechanical appliances, and the author [illegible]

he [illegible] preferable to give examples with which he is familiar rather than to take examples from other railways. It is, however, distinctly to be understood that the machinery here described is only to be looked on as representing certain types, and is in no case put forward as the best representative. Nor are the number of types considered as in any way exhaustive for dealing with general merchandise, there being throughout the country many examples of excellent electrical machinery designed to suit the special conditions of each station. To describe even a small percentage of them would be far beyond the scope of this article.

(A) Electrical Machinery for Handling General Merchandise in Goods Sheds and Warehouses.

The first principle governing the design of all the machinery here described is that its control should be simple enough for the goods staff of the traffic department to be able to work it. The electrical department and the locomotive department often jointly maintain the electrical equipment and the mechanical parts, but only the men of the goods department work the machinery.

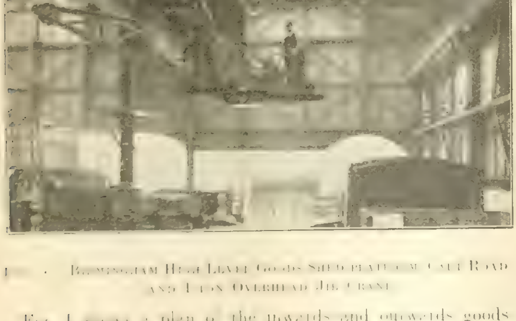


Fig. 5.—Birmingham High Level Goods Shed Platform, Cart Road and 1-ton Overhead Jib Crane.

Fig. 1 shows a plan of the inwards and outwards goods sheds and the yard at Newtown, Cardiff. Its reconstruction on the present plan was finished in 1906, and it was equipped with electrical machinery, and electrically lit with flame arc and glow lamps, the D.C. electric supply being taken from the Corporation at 460 volts for power and 200 volts for lighting.

Figs. 2 and 3 show plans of the high level goods shed and yard and the low level goods sheds (A and B) beneath, at Moor Street, Birmingham. The high level shed and yard has been at work for some three years, but the equipment of the low level shed, delayed by the war, was completed in 1916. It is equipped with electrical machinery and electrically lit with glow lamps, the three-phase, 25-cycle current being taken from the Corporation at E.H.T. supply and transformed down by the railway to 440 volts between phases for power and 220 volts and 110 volts for lighting.

Fig. 4 shows a plan of the goods shed with warehouse above and yard at South Lambeth. The equipment was finished in 1913. It is equipped with electrical machinery and electrically lit with flame arc and glow lamps, the D.C. current supply being taken from the Battersea Borough Council at 460 volts for power and 230 volts for lighting.

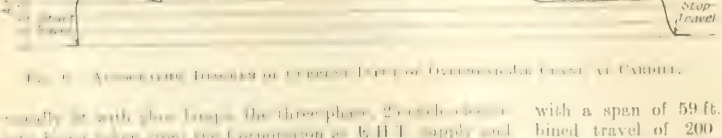


Fig. 6.—Ammeter Diagram of Current Taken by Overhead Jib Crane at Cardiff.

Overhead Travelling Cranes.

Fig. 5, of Birmingham high level goods shed, illustrates the arrangement of platforms, sidings and cart road for one type of shed used for general merchandise. It is essential that the cart road be free from all obstruction, and (short of a roof of great span and cost) no design of shed seems possible without a row of stanchions or piers along one or more platforms for carrying the roof. Where, as at South Lambeth, a warehouse is erected above the shed, rows of piers or stanchions along the platforms are essential.

The usual overhead travelling crane consists of a bridge spanning the building with a carriage at each end running on rails fixed to a gantry carried on the roof stanchions or pillars,

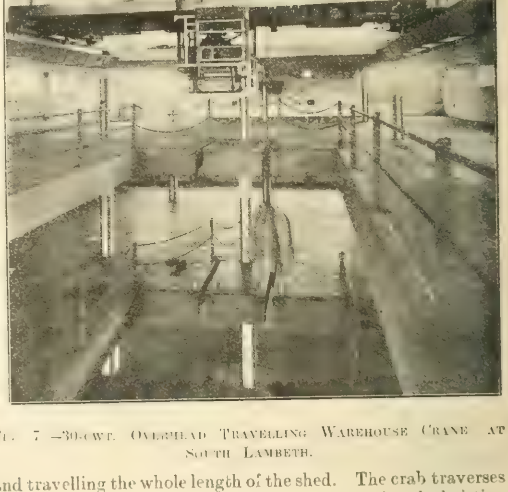


Fig. 7.—30-cwt. Overhead Travelling Warehouse Crane at South Lambeth.

and travelling the whole length of the shed. The crab traverses across the building on this bridge, the crab carrying the hoisting and traversing motor and gear. But for the stanchions on the platforms such a simple overhead crane as described above would be suitable for a goods shed. Since the goods department will not permit in the cart road obstructions such as the stanchions supporting roofs and cranes, a type of overhead crane has been developed in which a jib is hung under the crab. The sheave end of the jib can then be manœuvred under the gantry and between the stanchions, the jib radius being such as to command both the wagons and the road vehicle. Fig. 5 shows the position of the driver. The crane motor controller-handles are combined for slewing and hoisting and either travelling or traversing can be done at the same time as one of the former motions. In the Cardiff outwards shed (*see* Fig. 1) one such crane with a span of 47 ft. (jib radius 18 ft.) and a total travel of 280 ft. commands 46 wagons and from 50 to 60 road vehicles backed against the platform in the cart road. In the Cardiff inwards shed two such cranes with a span of 59 ft. 3 in. (jib radius 13 ft.) and a combined travel of 200 ft. command 26 wagons and from 30 to 60 road vehicles. In Figs. 1 to 4 these cranes are referred to as underhung jib cranes. The D.C. current at 460 volts is collected on the travelling bridge from trolley wires beside one gantry girder and distributed along similar wires attached to the bridge to be collected on the crab. Collector rings on the king post permit of the supply current passing through the main switch and a distribution board to the four motor circuits (travelling, traversing, slewing and hoisting),

each protected by an overload circuit breaker and a fuse in the other pole. Drum controllers start the series motors and bring them to full speed, while the hoisting motor has rheostatic notches for lowering the load. The slewing of the jib is preferably stopped by a pedal brake. It is inevitable that at times the jib is slewed into one or other of the stanchions, consequently the slewing motor gearing transmits its power to the jib through a friction clutch capable of delicate adjustment by a single large nut. The friction is just sufficient to transmit the power to slew full load at full speed. Arranged thus, no inconvenience is caused by slewing into an obstruction. Fig. 6 shows a composite autographic diagram of the current taken by one of the Cardiff cranes at 400 volts for all the motions when the hook was loaded with 1 ton.

For the crane at Birmingham, shown ini Fg. 5, the bridge has a span of 28 ft. 4½ in. and travels at an average speed of 250 ft. per minute for a distance of 404 ft. Two covered openings in the shed platform permit of goods in crates being raised from the two low level sheds to the high level platform. The supply is, as already stated, three-phase, which involves 15 collector rings on the king post to permit of supplying four electric motors and controlling them from the jib platform.

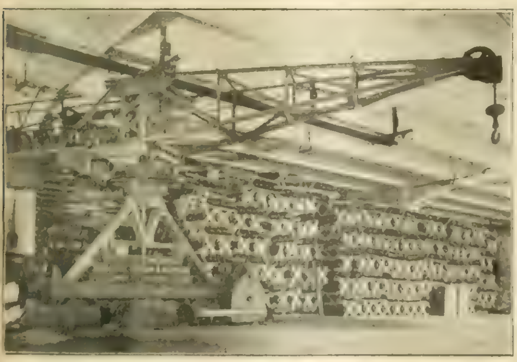


Fig. 8.—30-cwt. Walking Jib Crane at Birmingham Low Level, Shed A.

Two similar cranes (see Fig. 4) are provided in the South Lambeth goods shed, which is a ferro-concrete structure, the bridge having a span of 53 ft. 10 in. and the jib a radius of 23 ft. 6 in. The maximum load is one ton. The length of this shed is 465 ft., and the cranes command some 70 wagons and a corresponding number of road vehicles.

The plan, Fig. 4, indicates a well hole near the middle of the South Lambeth shed, which extends to the top floor of the warehouse above the shed. An overhead travelling crane shown in Fig. 7 can hoist a load of 30 cwt. at 200 ft. per minute from any wagon covered by the 30-ft. traverse of the crab. The plan shows the crane spanning two roads only, but an electric traverser at the bottom of the well allows wagons on the third road to be brought under the crane hook. This overhead travelling crane can deliver to or from wagons within reach of the hook on to the first, second or third floor of the warehouse above. Slots are provided in the edges of the second and third ferro-concrete floors at the boundary of the well which allow the crane rope to be [illegible] and to deliver goods on to it. All motions of this crane are electrically worked.

An interesting example of the overhead travelling crane with revolving jib is installed at the [illegible] goods depot. Two cranes, each to lift two tons at a jib radius of 21 ft., have been erected in a shed [illegible] ft. long beside the canal shed. They were provided to deal with pipes shipped from Messrs. Stewarts & Lloyds' Works, hoisting them out of barges in the canal dock on one side of the shed, and delivering them into railway wagons on either of two sidings in the shed itself. The span between the crane gantry rails is 42 ft. 10 in. The electric supply, purchased from the Shropshire, Worcestershire

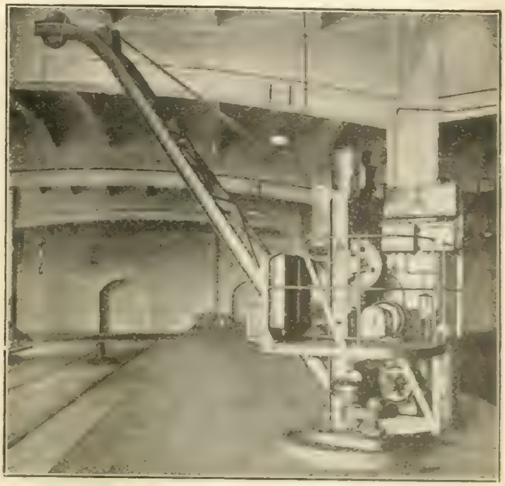


Fig. 9.—[illegible] Fixed Jib Crane at Birmingham (Low Level) Shed [illegible].

and Staffordshire Power Co. is three-phase, 25 periods, 22[illegible] volts between phases, and is also used for lighting the shed and yard with gas-filled and ordinary glow lamps.

Jib Cranes

Under certain circumstances, one of which must be that head room makes an overhead travelling crane impossible, the chief disadvantages of the fixed jib crane on a shed platform can be overcome by mounting the crane on a travelling

Fig. 10.—[illegible] Gantry Crane [illegible]

carriage. The carriage [illegible] of a [illegible] with the platform, the top of the crane structure being supported by rollers [illegible] a rolled steel joist fixed to the roof. Such a crane at Birmingham is shown in Fig. 8. The plan of the shed A, Fig. 5, shows the [illegible] (including the [illegible] load), the [illegible] and having a radius of 18 ft. [illegible] On the straight the crane travels at 200 ft. per minute and the jib radius of 18 ft. commands nearly the whole platform, [illegible]

siding, the cart road and part of the angled siding. The head room available between platform and ferro-concrete roof beams is only 14 ft. 6 in.

Where a walking jib crane is not suitable, or its expense is not justified, it is occasionally necessary to install fixed jib cranes on a goods shed platform. Both the Cardiff and Birmingham plans (Figs. 1 and 3) show such cranes, the reason for their presence being in each case want of head-room. Fig. 9 illustrates one of two 20 cwt. cranes in shed B at Birmingham, their positions being shown by circles in Fig. 3. A radius of 14 ft. 9 in. allows each crane to command a wagon in the siding and a road vehicle in the cart road. The load can be lowered on a hand brake or by using the three-phase hoisting induction motor as a brake. It is preferable to stop the slewing motion of all jib cranes of moderate capacity by a foot or hand-worked brake, which can be applied gradually, rather than by an automatic electric brake which stops the jib suddenly and may leave the load swinging dangerously. The crane in the illustration has a pedal lever brake.

Lifts.

A modern goods shed will have a warehouse built above it wherever this is possible, provided a warehouse is necessary. The bulk of the general merchandise to be stored is taken up by lift from the shed platform on to which it is delivered from wagon or road vehicle. Unfortunately no photograph of a lift can convey any idea of its construction. A typical goods lift may be illustrated by one of the 30 cwt. South Lambeth warehouse lifts, of which (as seen from Fig. 4) there are four. These lifts travel a distance of 69 ft. 1 in. from the basement below the shed platform to the third floor of the warehouse above. Two cages are 7 ft. 5 in. by 8 ft. 9 in. in plan, and the other cage is larger. The cages have two opposite openings closed by collapsible gates so placed that at one entrance goods can be received from road vehicles backed right up to the cage, while goods can be trucked to the other entrance from railway wagons. The electric motor and winding gear is at the top of the well on the fourth floor. In lifts of this type the winding gear may be a spirally grooved drum on which the ropes carrying the cage are coiled and to which the end of each rope is fixed, or a V-groove sheave or sheaves into which the ropes wedge, the power being transmitted wholly by friction. Both are successfully used for lifts of moderate capacity, but opinions and even experience differ as to which type is preferable. Long rope life is important, not so much from the cost of replacing worn out ropes, but because such replacement puts the lifts out of action for some time. One of the conditions to secure long life is that the diameter of drum or sheave should not be less than so many times the diameter of the rope, depending on the rope speed, and it is cheaper to provide the necessary diameter in a sheave than in a drum. Another essential is to have a factor of rope safety of at least ten, and it is easier to provide four sheaves, each with a rope for the cage, than to have the same number of ropes on a drum, though this can be done. It is general practice to counter-balance the weight of the cage and half the maximum load for which the lift is made, since usually the normal load is about half the maximum load. In this case the power supplied has only to accelerate the moving parts and overcome friction. For direct-current supply the motor should be shunt wound with series field turns for accelerating the load. For three-phase supply the induction motor must have a wound rotor with slip rings for the acceleration period. Essentially the switchgear consists of two direction switches, one "up" and the other "down," and switches for cutting out resistance in the armature of a D.C. motor, or the rotor of an induction motor, during acceleration. Very satisfactory results are obtained if each switch is opened and closed by an independent solenoid. For goods lifts between two floors only, push buttons for "up," "down" and "stop," both inside the cage and outside at each landing, give maximum economy in labour, dispensing with a lift attendant and allowing the goods station staff to fetch the lift from either floor or to send it to either floor. When the lift serves several floors the same arrangement may be used, but it is often worth while to provide full automatic control. This control provides a button for "up" and another for "down" to move the direction switches, and a button for each floor, the cage stopping automatically whether it is called to or despatched to that floor. The complete set of push buttons is duplicated inside the cage and at each landing. Whichever system is used, overwinding switches at the top and bottom of the travel prevent over travel by acting through the switchgear, while it is wise to have a second set of limit switches which cut off the supply should the automatic switches fail to act. Contacts on the collapsible gates secure the electric interlocking of the control switchgear so that the cage cannot be moved until all gates are closed. Mechanical interlocking secures that no gate can be opened until the cage is opposite a landing, and then only the gate at that landing. The cage is stopped by an automatic electric brake acting on a brake pulley on the motor spindle, the supply of current to the motor pulling off the brake against a spring or weighted lever, preferably the latter, which normally keeps the brake on. The South Lambeth lifts have an average speed of 120 ft. per minute, which is about the maximum speed for which full

Fig. 11.—12-ton Goliath Crane, with Wings extending the Bridge, at St. Phillip's Marsh, Bristol.

automatic control can give reasonably accurate stopping of the cage at any landing, whether loaded or empty. For lifts up to two tons capacity the power to work the solenoid switchgear will be as much as or more than that taken by the motor.

Transporters.

It may be necessary to store in the warehouse bars or rolled metal sections or pipes, of a length which the lift cage cannot take. To provide for this at South Lambeth a transporter has been provided. A joist fixed to the ferro-concrete roof

Fig. 12.—Wagon Hauled by Clyde Capstan at Birmingham High Level Yard.

projects 20 ft. beyond the face of the building. An electrically worked jenny travels on this joist and can hoist 30 cwt. the full height of 66 ft. in 20 secs. The goods are landed on hinged flaps at each floor, but it is an improvement on this design of transporter for the jenny to travel into the building some 4 ft., slots to take the rope being provided in each floor. In either case the transporter is worked by push buttons from every floor served, through solenoid contactor switches.

Runways and Conveyors.

The runway, consisting of a travelling jenny running on a joist, has not been so far largely used in British goods working

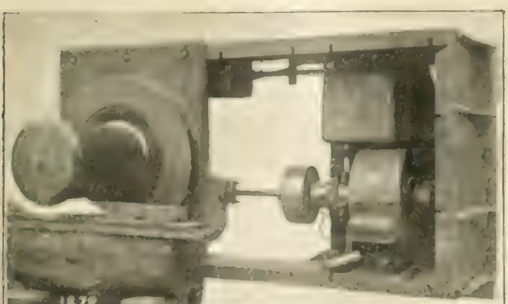


Fig. 13.—Clyde Capstan, [illegible]

though some examples exist. While this is often the only method that can be used for equipping an existing goods shed with a low roof, it cannot compete in speed with the overhead crane which, in one or other of its forms, is usually now installed in modern goods sheds designed with sufficient head room for such a crane.

In this brief sketch it is not possible to mention the many forms of conveyors used for loading and discharging goods in warehouses, but in dealing with general merchandise the class of goods is so varied that the usefulness of a conveyor is rare.

(B) Electrical Machinery for Dealing with General Merchandise in Goods Yards.

Jib Cranes.

Every goods yard must have a jib crane, either worked by hand or by power, so placed that a wagon can be shunted within its radius for the purpose of loading or unloading. It must be accessible to road vehicles. Such a jib crane at Moor Street, Birmingham, is indicated on the plan, Fig. 2, outside the south end of the goods shed. The radius of the jib is 15 ft. A load of six tons can be raised and lowered

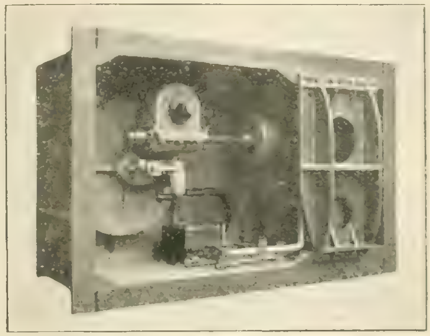


Fig. 14.—Clyde Capstan, looking at Bottom of Box [illegible] Edge.

at a speed of 20 ft. per minute, the lowering as in the case of the jib crane already described being by means of a separate hand lever brake or by using the induction motor as an electric brake. Slewing is checked and stopped by a foot pedal brake.

Goliath Cranes.

Probably the earliest examples in goods yard working of bringing the crane hook to the wagon on the siding, and of bringing the load to the road vehicle, or *vice versa*, is to be found in the gantry overhead crane. The sides of the space, including sidings and cart road, to be covered by the crane are enclosed by two structures or gantries, each carrying a rail at the top. On these parallel rails travels the bridge of an overhead travelling crane and the crab traverses the span on the bridge. The inconvenience of the gantries is obvious.

In the goliath crane each gantry has been shortened into a leg carrying the crane bridge, each leg being mounted on a carriage which travels on a line of rails flush with the yard paving. Fig. 10 illustrates a [illegible] goliath crane at South

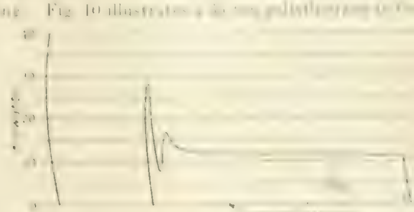


Fig. 15.—[illegible] Clyde Capstan [illegible]

Lambeth yard. [illegible] Fig. 4. The span between the rails on which the travelling gantry runs is [illegible], and the length of travel of [illegible] can be covered in [illegible] minutes. Two roads, each of [illegible] railway wagons of average size, can be loaded or unloaded without any shunting. The crab has a cross traverse of [illegible] in one minute. Two independent hoisting drums, each with its own motor and speed reduction gearing, are provided on the crab for [illegible]. [illegible] seen in Fig. 16, the load being on the [illegible] hook. It is [illegible] that the quality of a goliath crane [illegible]

trolley wires carried from brackets on poles outside one leg. At South Lambeth the poles would have so interfered with the cart road that a length of London County Council standard tramway conduit was laid down (seen in Fig. 10) just inside one travelling rail. One leg carries two "ploughs" in parallel to collect from the conductor rails in this conduit. This crane is so busy that it is very difficult to get occupation for necessary overhaul and repairs.

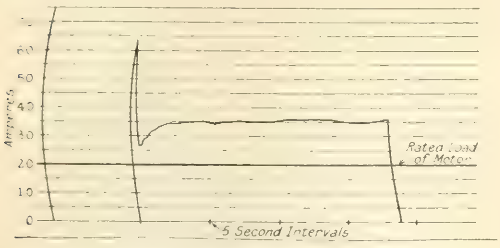


Fig. 16.—Autographic Current Diagram of Clyde Capstan at South Lambeth.

Fig. 11 shows a 12-ton goliath crane in the St. Phillip's Marsh goods yard at Bristol. The distance between the travelling rails is 60 ft., but owing to the lay out of the sidings and cart roads the bridge is carried out as two wings beyond each leg so that the hook can traverse 83 ft. and load or unload road vehicles outside each gantry leg. The rails on which the gantry

Fig. 17.—Upper Part of the 30-ton Wagon Lift at Birmingham High Level.

travels for its total length of 100 ft. are on a gradient of 1 in 100. Electricity is taken from the Bristol Corporation supply as D.C. current at 460 volts. Rheostatic braking is employed on the travelling motors when going down the gradient, the crane being started and accelerated to full speed and then held on the first or second braking notch of the controller.

(C) Electrical Machinery for Moving Wagons in Goods Sheds and Yards.

Electric Capstans.

After a train of wagons has been left in position for unloading in a yard or shed any further movement of the whole or part of the train, or of individual wagons, must be made either by a shunting engine, which, with its engine crew, may be kept idle under steam for many hours, or by a power capstan. The usual form of electric capstan includes a bollard, rotated at about twice the speed which would give to a rope coiled two or three turns round it (without any slip) the maximum speed needed for hauling maximum load. The bollard is rotated through worm, or worm and spur gearing by a compound wound D.C. or induction three-phase electric motor started light by a starting switch in the capstan box, the switch being closed by pressing a spring pedal. The capstan man keeps the switch closed by his foot and must use both hands to haul in the slack tail-end of the rope, giving sufficient tension to secure the necessary hauling pull. Considerable experience and skill is needed to manipulate the rope properly in all the various manœuvres of hauling trains or single wagons and in turn-tabling or shunting single wagons. Owing to this handling, hemp ropes must be used, and for the usual size of capstan to pull one ton the rope is very heavy when wet. The power being transmitted from bollard to rope by friction, about half the power is lost in slipping and

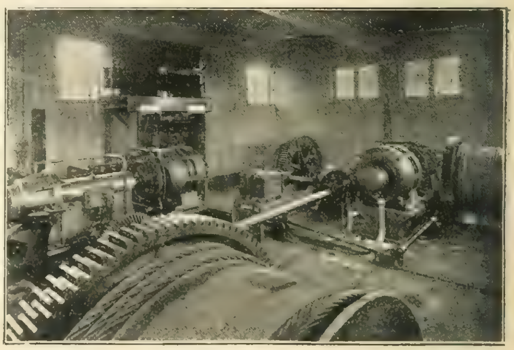


Fig. 18.—Birmingham 30-ton Lift—Hoisting Machinery.

the ropes wear very rapidly. In very busy yards the annual pre-war cost of hemp ropes per capstan was anything from £15 to £20.

For the Clyde docks a capstan has been developed, known as the Clyde Capstan, in which the rope is fixed to the bollard and has never to be handled by the capstan man. Consequently a steel rope can be used, with the result of an annual saving in rope renewals of from 80 per cent. to 90 per cent. Fig. 12 shows a wagon in Moor Street, Birmingham, at the finish of its haul by a Clyde capstan, the spring-catch hand-lever being in the mid position. This type of electric capstan has been used in all the Great Western yards equipped with electrical machinery, 58 being employed in the three stations shown in Figs. 1–4 and half as many more elsewhere. The worm and spur gearing for reducing the speed of the motor to that of the bollard is connected to or disconnected from the bollard by a jaw clutch within the bollard, put in or out through links by the hand lever shown in Fig. 12. In the mid position shown the clutch is in and the bollard in gear, but the switch is out. If pushed forward into the notch the clutch is out and the bollard free to revolve for hauling out the 180 ft. or 200 ft. of ⅝ in. diameter steel rope by means of the tow hook attached to the rope end through a short length of tow chain. The hook, if held to the axle box guard by the pull of the capstan, will fall off when the pull stops. If from the "clutch out" position the capstan man pulls the

catch lever towards him till the catch is in the first notch (visible in Fig. 12) the jaw clutch in the mid position being already in, the switch connecting the motor to the supply is closed. If the motor is a D.C. motor the first notch position connects the plain series motor through a resistance which will give half speed. If, as in Fig. 12, the motor is three-phase, this position of the lever connects the motor in star. In either case this position is used for hauling single wagons, for turntable work and for winding in the idle rope on the bollard, the lever spring-catch holding the switch in this position.

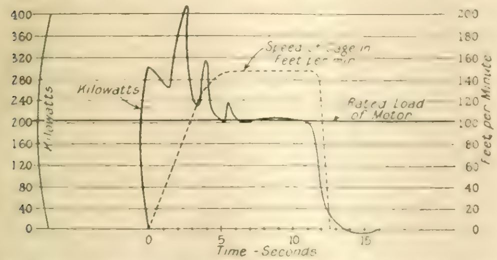


Fig. 19.—Autographic Kilowatt Diagram and Speed Time Curve of Birmingham 30-ton Lift.

Pulling the lever further over connects the motor direct across the supply for D.C. working, or in delta for three-phase. Between the gearing and the motor is a centrifugal clutch which allows the motor to attain sufficient speed to exert the necessary torque to haul the load before that load comes on, which, when trains of 200 tons are hauled may be more than 200 per cent. of the rated load of the motor. For the few minutes that a capstan load is on at a time the one-hour rated motor, either D.C. or A.C., is quite satisfactory. Pushing the lever back to the notch beyond mid-position at the conclusion of a haul opens the switch and frees the bollard by forcing out the jaw clutch, while in the latest design of capstan pushing the lever still further over applies a brake to the bollard, which, by stopping it, prevents the hook with a short piece of rope swinging round the bollard if still rotating by its own momentum. Fig. 13 shows the inside of a cast iron Clyde capstan box placed on edge, as seen from the front with the top covers off. The bollard, motor, centrifugal clutch and stringer carrying the switch and motor are clearly visible. The box sits on a brick or concrete pit deep enough to allow a man to work inside. The switch spindle carries a spur sector just visible between the switch and the capstan box which is worked by the hand lever, through another spur sector of course not shown in the illustration. The [illegible] for putting the friction clutch in and out have been removed since their connection to the hand lever is dependent on the top cover of the capstan box being in place. Fig. 14 shows the box as seen from below with the stringer carrying motor and switch box. The centrifugal clutch is again visible as also the worm gear box and the spur gear box beneath the bollard. The wiring junction box is shown, as also the [illegible] link and crank lever which works the jaw clutch in the bollard.

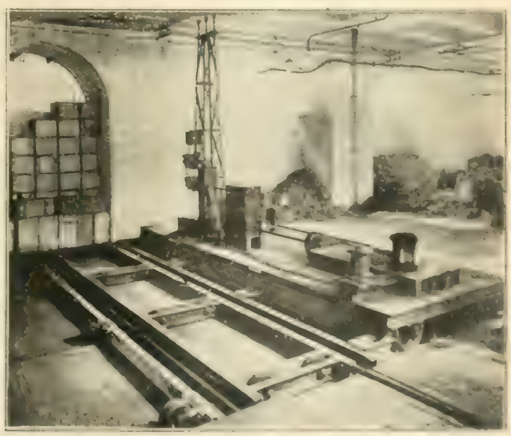
In the three-phase capstans at Birmingham the motors are squirrel cage induction motors, the centrifugal clutch allowing the motor to get near synchronous speed before the cast iron friction blocks grip. Fig. 15 shows an autographic kilowatt diagram taken from one of these capstans not hauling a load but lifting a weight over a pulley. The starting peak is due to the lever being pulled over and the delta connection [illegible]

lbs. at 165 ft. per minute three-phase, or 110 ft. per minute D.C. with full pressure on the motor. The single reduction spur gearing is so designed that by altering the ratio between pinion and spur wheel the speed can be (permanently) reduced from a maximum of 200 ft. or 180 ft. per minute to a maximum of 140 ft. per minute with a corresponding increase in load. These capstans can give a pull of 5,000 lbs. at about 100 ft. per minute. Very little skill is required to work them except for turntable work, but turntabling is very quickly learnt.

Wagon Lift

Lifts for moving goods to and from warehouses have already been referred to. The Birmingham goods station has had to adapt its working to the circumstances of the site. All trains are moved on the high level and the large sheds are immediately below (see Figs. 2 and 3). The high level shed deals first with perishable market traffic and afterwards with general merchandise. The same conditions hold for low level shed B, while shed A was primarily intended for metal traffic. A 20-ton wagon lift and a 30-ton wagon lift shown in part in Figs. 2 and 3 serve shed B, and another 30-ton lift serves shed A. All inwards traffic wagons have to be lowered by lift to the low level sheds to be dealt with, and all outwards traffic coming to the low level sheds is there loaded into wagons and the wagons raised by lift to the high level yard for marshalling into trains. Fig. 17 shows the upper structure of the two 30-ton lifts above the high level yard. In the view the cage is at the top.

The following description refers to the lift in the foreground of Fig. 17 serving shed B. The cage can take a wagon 25 ft. over buffers, and such a wagon weighing with its load 30 tons has been raised and lowered a distance of 30 ft. 4 in. at a measured average speed of 137 ft. per minute. So generally



[illegible]

[illegible]

The stators of the two 120 H.P. three-phase induction motors are connected in parallel, but the two rotors are separate electrically. The maximum peak load at starting, either raising a 30-ton load or lowering the empty cage (*i.e.*, lifting the counter weights) is 420 kw., as shown on Fig. 19, which is an autographic kilowatt diagram taken from the lift serving shed A with the cage loaded with 30 tons. A speed-time diagram is superposed. The controlling switchgear consists of contactor switches closed by single-phase alternating current solenoids. Either side of the main switch and overload circuit breaker in the middle of the top panel are the two direction switches (up or down) closing the stator circuit connected correctly for direction. On the lower panel are three rotor starting and short circuiting switches for each motor. The

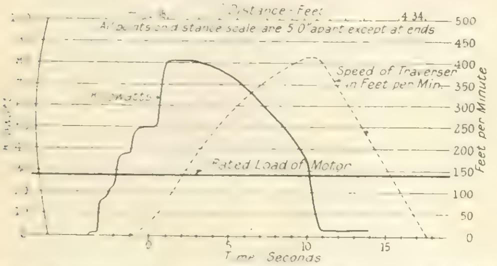


Fig. 21.—Autographic Kilowatt Input Diagram and Speed Time Curve of 30-ton Traverser at Birmingham, Shed "A."

rotor resistances are above the switchboard. The stopping of the lift is provided by a brake embracing a pulley on each motor shaft, both brakes being visible between the motors and the worm box in Fig. 18. Each brake is put on by a weighted lever and taken off by a three-legged solenoid, one leg in each phase. To ensure synchronism of the brakes and to simplify adjustment, the two brake magnets have been brought to the middle of the floor, as seen in Fig. 18, and the plungers coupled. The figure shows the links and rocking shaft between the magnets and one of the brakes.

The lift is worked by a master controller in the cage, its handle being interlocked with the gates, the chocks on the cage rail, so that the cage cannot be moved unless the chocks prevent the wagon from moving. Since it is not possible to obtain by the master controller exact alignment of the cage rails with the siding leading to the lift, an "inching" push button closes one or other of the direction switches with all resistance in the rotor circuit. Two sets of limit switches at top and bottom of the cage prevent over-travel. The first switch opens the controller circuit, and should this fail the second switch cuts off the supply. The whole of the working of the sheds A and B depends on these lifts, and they have proved very satisfactory.

Inspection of the plan in Fig. 3 will make it clear that the only way in which wagons can be transferred between the lift in shed A and the sidings, or between the two lifts in shed B and the sidings, is by means of a traverser in each shed. These traversers are indicated in the plan together with the four lines of rail on which each traverser runs. These rails are laid in each case in the road, and of course flush with it, since all road vehicles must pass over them. Consequently very little clearance could be allowed between the rails of the sidings and the rails on which the traverser runs. In the actual design this distance has been reduced to only 1½ in., and the way in which this has been made possible is clear from Figs. 20 and 23. In shed A there are only two sidings 100 ft. apart, and the time taken in alignment of rails between traverser and sidings was not of supreme importance. The motive power on the traverser is provided by a cascade induction motor rated at 30 H.P. of the one speed type (the motor is hidden by the rotor resistances in Fig. 20) arranged to creep at 5 per cent. of normal speed when exerting full load torque. This permits of easy alignment of traverser and siding rails. By using pitch chain drives for the eight driving wheels (four wheels per shaft) motor and gearing is made accessible above deck. The traverser can travel the whole width of the shed with a 30-ton load at 275 ft. per minute. Fig. 21 shows an autographic kw. diagram of such a journey, but for a length of 70 ft. only, so that the average speed was 240 ft. per minute. The capstan shown on Fig. 20 is of the slipping rope type for hauling wagons on to and off from the traverser. It is worked by a squirrel cage induction motor with high resistance rotor windings. The capstan head can give a pull of 750 lbs.

In shed B there are eight parallel lines of sidings, some of which are only a few feet apart, between which and one or other of the two lifts it is necessary to transfer wagons at the greatest possible speed owing to the perishable traffic dealt with in the shed in the early morning. Not only, therefore, must the traverser have quick acceleration to secure high average speed, but it must be able to stop and align rapidly with any siding. To secure all these features the traverser shown in Fig. 23 consists of a locomotive with a detachable traversing carriage at each end, one to serve each lift. The figure shows an induction motor, which runs at nearly constant speed, coupled to the rotating pump of a Hele-Shaw variable speed oil transmission gear, the function of which is to turn the constant torque and speed of the electric motor into variable torque and speed required by the traverser with an efficiency of between 80 and 90 per cent. Each line of four driving wheels on the locomotive is driven by an oil motor through a pitch chain, so that the oil motors are above and accessible. The torque in the oil motors is regulated

Fig. 22.—Loading China Clay Conveyor and Wagon Tipping Frame.

by the handwheel shown in Fig. 23 at the back of the oil pump. The handwheel alters the stroke of the plungers in the pump, increasing or decreasing the oil pressure to the motors. The regulation of the speed is so perfect and easy that with a test load of a 20-ton wagon on one traverser anything from a creeping speed of a few inches per minute up to a maximum of 600 ft. per minute was obtained, and for a test distance of 220 ft. an average speed of 380 ft. per minute. Rapid reversal

at creeping speeds makes rail alignment quick and easy. The capstan head shown in Fig. 23 is worked by a separate oil motor.

Space does not permit of any detailed description of the electrical motors and switchgear used in the above machinery, the intention being to show tendencies rather than details. If a wider railway field had been drawn from, the same tendencies would have been illustrated by other examples, which, as machinery, might be either better or worse than the examples selected to illustrate the equipment of sheds and yards to deal with general merchandise.

When special goods are handled the problem is quite different, and the machinery to deal with it is quite beyond the scope of this article. One example, however, of dealing with one class of goods only of uniform size and weight may be referred to in the shipment of china clay at Fowey, Cornwall. Fig. 22 shows a ship being loaded with china clay in bulk by means of a 36 in. belt conveyor. The figure shows a wagon on a tipping frame, the clay being discharged into the hopper which delivers through a hand regulated valve on to the travelling belt below the hopper spout. Above the jetty deck the structure carrying the belt (which is troughed by means of idle pulleys on each side) is hinged, the extreme end being raised or lowered by ropes and electrically driven gearing in the tower to suit size of vessel and state of tide. The belt at

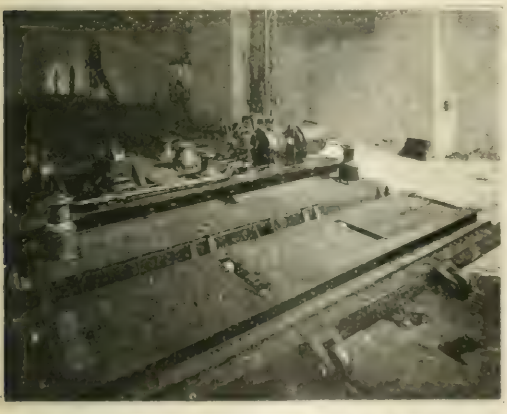


Fig. 22.—[illegible] Wagon [illegible] Belt Conveyor, [illegible]

the tip delivers into a [illegible] spout, at the end of which is a trimming nose which enters the hold [illegible] and delivers to any part of the hold. The belt is driven through [illegible] gearing by a D.C. shunt wound electric motor [illegible] on the driving drum, and adjustments for [illegible] of belt due to load or shrinkage due to humidity being [illegible] by a vertical loop of belt passing under a weighted and guided pulley. The figure shows horses being still used for turntables and manœuvring wagons, but for many years past this work has been done by [illegible] electric capstans [illegible] which have displaced all horses and most of the engine shunting in the yard. The speed of working the conveyor depends on the rate at which wagons can be manœuvred by the turntables on to the tipping frame, tipped, and the empty wagon removed. When working at full pressure 200 tons of clay per hour have been shipped by the conveyor, which implies the tipping of a wagon on the average every two minutes.

This conveyor was installed to increase the speed of loading ships, and the electric capstans were introduced to increase the speed of handling wagons. The result has been an actual saving over horses, but at the same time wages paid on a tonnage basis have largely increased.

War has prevented the electrical equipment of a new steel jetty with conveyor and cranes capable of loading either two vessels at once or two holds in the same vessel.

The single instance given of the use of mechanical appliances for dealing with large quantities of one material such as china clay, will serve to illustrate the difference between using mechanical devices to handle such goods and to handle general merchandise. Uniform material, or uniform packages of material, can with advantage be handled mechanically by

Fig. 21.—[illegible] Jib Crane at Birmingham High Level [illegible]

machinery which greatly increases the amount handled in a given time. General merchandise can only be handled by machinery to a limited extent, the extent being in general governed by the size and weight which can be hand-trucked, and not by the possibility of greatly increasing the average speed of working.

Automatic Sub-Stations for Railways. In a recent issue of the Electric Railway Journal Mr. W. D. [illegible] deals with the question of reducing railway operating costs by using automatic sub-stations. It appears that [illegible] automatic equipments have been installed on no less than seven different railway systems in America, and 30 equipments are under construction [illegible]. The automatic control apparatus is designed to do the work of the sub-station operator, and in addition [illegible] to limit the amount of current taken from the machine. The starting up and shutting down of the sub-station equipment is entirely effected by electrically-operated contactors which are controlled by [illegible] relays, eliminating [illegible] the attendant except as may be required for periodical inspection. The portion of the equipment [illegible] is a load limiting resistance which is automatically inserted between the direct-current machine and the trolley bus-bar when excessive loads are drawn by reason of [illegible] acceleration [illegible] occurring on the line. [illegible] automatic stations [illegible] to 1,500 kw. As an example of the saving which can be made on a typical interurban road, a calculation has been made for a hypothetical road having three sub-stations, each of 500 kw. capacity, and operating [illegible]. The estimate shows [illegible] per annum, a saving [illegible] 1,800 per annum and a total saving [illegible] per annum.

The Present-Day Handling of our Foodstuffs by Machinery.

Summary.—The author deals with the handling of cereals, seeds, nuts and similar bulk goods by pneumatic means, both stationary and floating, as well as by bucket elevators mounted on pontoons. The remainder of our imported foodstuffs, such as frozen carcases of mutton, quarters of chilled beef and bunches of bananas, are generally handled in the unpacked state and by continuously working machines, while other items of food, such as tea, cheese, frozen rabbits and poultry and fruit are handled in cases and crates. The machine described as best adapted for this purpose is one combining the attributes of elevator, conveyor and lowering device; the whole of the apparatus can be lifted in its housed position by the ship's crane into a working position between hatch combings and gunwale, the two ends of the apparatus plumbing the hold and the quay or lighter where the goods are received. Auxiliary handling devices are also described.

OUR lack of adequate plant for handling our foodstuffs by mechanical means is not only to some extent responsible for the high prices of our daily bread, but also, indirectly, for the loss of some of the food by perishing,* as well as through deliberate exposure to the U-boat menace. It will, therefore, not be without interest to investigate the different systems at our disposal for the handling of our food mechanically in the hope that a wider knowledge of the subject will be instrumental in the more general adoption of machinery in all our docks where food cargoes are handled. Before going into details it might be mentioned that the antiquated methods of handling such cargo by cranes and hand labour are quite inadequate, not only because we cannot spare the men, but also because we import more food per head of population than any other nation, and as we do not produce it ourselves we must be prepared to handle it mechanically at the docks. The inefficient state of our facilities for unloading steamers has been so fully realised during the last three years that at many centres where our food is received extensive additions and alterations have either been made or are contemplated in the near future; thus, the Port of London Authority contemplates the expenditure of half-a-million of money on a new grain handling and storage scheme for a granary to accommodate 40,000 tons. Cork, in Ireland, will instal a pneumatic grain handling plant for unloading steamers, &c.

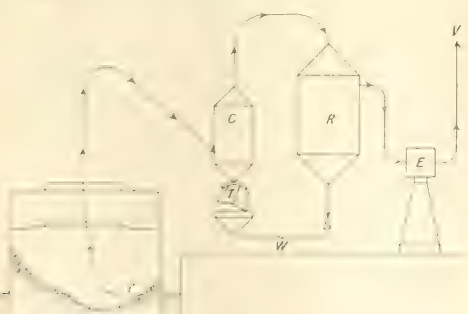


Fig. 1.—[illegible]

We consume annually 32,000,000 qrs. of grain, of which we have to import 25,000,000 qrs. Our annual meat consumption is 1,625,000 tons, of which 533,000 tons are imported annually in a frozen or chilled condition. In addition to this prodigious quantity we have to handle at the docks bacon, cheese, tea, fruit, potatoes, sugar, &c. Let us first see how these materials are [illegible] mechanically by those who are progressive enough to realise the advantages of employing the machine for such work from the standpoint of national economy, and [illegible] the [illegible] for such work as the machine cannot do.

The handling of our foodstuffs can be conveniently divided under two heads:—

1. Wheat and other cereals, small nuts and seeds, and [illegible] handled in bulk by pneumatic and bucket elevators.

2. Frozen meat and other foodstuffs handled as piece goods by the Donald elevator conveyor and sundry portable or stationary conveying devices.

Handling.

We will first deal with the bulk handling of grain, &c. This can be unloaded by pneumatic means, that is, sucked or pumped out of the ship's hold while floating in a stream of air; the alternative method is by means of the well-known bucket elevator mounted in some way, either stationary or floating. All these mechanical unloading devices are either part of a warehouse or granary plant or they are portable devices. In the first instance they are mostly stationary; in the latter

Fig. 2.—A Floating Pneumatic Grain Handling Plant.

they may be mounted either on rails along the quay or on pontoons, when they can proceed under their own power about a port, or they may be lifted bodily on to the vessel. Such floating devices are generally used to unload from an ocean-going vessel to a coaster or canal barge, while in the case of stationary plant the vessel to be unloaded must be moored alongside the quay or a dolphin. Want of space does not permit of our entering very fully into the details of these machines, so that we must confine ourselves in the main to the description of the principle upon which their action is based, and by the help of the accompanying illustrations we think they will be sufficiently understood and their importance realised.

The Pneumatic or Suction System of Grain Handling.

The fundamental principle upon which this system is based is the same as it was when invented and employed by Mr. F. E. Duckham in the early nineties of last century. The improve-

* [illegible]

ments made since then relate principally to the accessories, which are now so constructed as to reduce the former great leakage of air to a minimum, with the consequence that much smaller pumps can be used, and even rotary exhausters for small plant. The type of high-speed pumps now employed is vertical and a marked improvement on the old slow-speed horizontal type. The driving power required for such modern installations is principally expended in maintaining a partial vacuum of about 8 in. of mercury. Although the power consumed has thus been much reduced it still requires about 2 H.P. hours per ton of grain handled, which is more than what would be necessary for a bucket elevator. Yet it is worth while expending a little more power, as the advantages gained by the employment of the pneumatic system are great, owing to its flexibility and great capacity, and as it dispenses entirely with the expense of trimming.

The system is based on the same principle as the pump, and has, since its further development, been largely built (as already mentioned) both stationary and portable on wheels and track,

Fig. 1.—Pneumatic Grain Unloader at Messrs. Smith's Star Works, Newport, Mon. [illegible]

as well as floating. Its introduction marked an epoch in mechanical handling; it differs vastly from all earlier methods in its application, as the grain does not come in contact with any mechanical working parts, but is simply pumped or sucked through a pipe, and even this is barely touched by the grain except when negotiating curves. The modus operandi will be best understood by the accompanying diagram, Fig. 1. The pneumatic elevator sucks the material through a nozzle N and a series of pipes, some of which are flexible, from the ship's hold to an elevated canister C, which it leaves via an air trap T for its destination. An exhauster E furnishes a partial vacuum of 7 in. to 8 in. of mercury by pipes connected with the said canister C. As the air is naturally laden with dust which is picked up with the wheat, this has to be eliminated by the dust collector B, as the [illegible] and enter the air pump.

The collected dust escapes at *S*. Since the wheat cargo has generally according to the custom of the trade to be delivered as received, this dust is mixed in again, so that at *W* the wheat and its dust are delivered together precisely as the cargo was brought into the country in the ship. As regards capacity, it might be mentioned that single plants have been constructed and run successfully to deal with a maximum quantity of 250 tons per hour under good conditions, with a total personnel of 12, including those in charge. The transport line in a well-constructed plant is fitted with swivelling and ball joints and flexible hose, by means of which any point in a ship's interior can be reached without interruption in the work of unloading; a continuity of operation is thus attained which results in a high average hourly capacity.

Fig. 2 gives a photographic view of one of the floating suction plants with two suction nozzles, as built by Messrs. Henry Simon (Ltd.), of Manchester, who are the principal makers of such floating loading devices especially adapted for large capacities.

At the time the system was introduced it was only available for big installations owing to the great initial cost involved, and the rather excessive consumption of power, yet the advantages of the system and the ease with which all corners of a ship's hold can be reached by a hose for removing the grain, render such installations economical none the less, on account of the saving of the very considerable trimming expenses involved by the employment of all other methods of unloading.

Fig. 4.—Suction Nozzle of Pneumatic Grain [illegible]

Modern improvements, particularly in the direction of more suitable exhausters, have considerably reduced the power expenditure, and whereas it formerly used at least [illegible] per ton of grain handled per hour, it can be done to-day with only 2 H.P. or even less. The power consumption [illegible] depends upon the height of the lift and the distance which the grain has to be conveyed horizontally, and the above are therefore only average figures, and in some cases [illegible] the power expenditure [illegible] per ton per hour. [illegible]

with a minimum of expense. An advantageous feature of the pneumatic system is that by its means the grain, &c., can be delivered right into the granary without any auxiliary handling, and we shall see that this does not apply to other systems of handling our daily bread, as additional handling devices are generally necessary for moving the cargo from the quay.

A typical example of a small pneumatic plant is illustrated in Fig. 3, which represents an installation erected for Messrs. Smith's Star Works, Newport, Mon., by Messrs. R. Boby (Ltd.), Bury St. Edmunds. With this plant two men can unload a barge in 1 day of 10 hours (one man in the barge and one in the granary). Prior to the installation of the pneumatic plant it took six men in the boat filling the grain into sacks, one on the hoist, and three to truck the sacks from the hoist to the warehouse floor, making 10 men in all, who were occupied for three days of 10 hours.

The capacity of the plant depends on the state of the tide in the River Usk; at the lowest tide, when the suction nozzle is practically at the bottom of the hold, there is a vertical lift of 67 ft., with a capacity of 24 tons per hour. At high tide (*see* Fig. 3) the capacity is 28 tons per hour, with a power consumption of 28 H.P. according to the reading of the instruments on the electric motor. Fig. 4 shows the method by which the hose is plied in the barge. The vacuum employed for the suction is 8 in. of mercury, and the cost of the complete installation erected, but minus the electric motor, was £600 at pre-war rates.

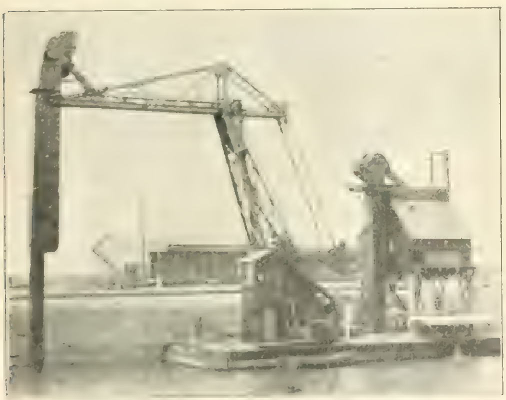


Fig. 5.—Floating Bucket Elevator [illegible]

THE FLOATING BUCKET ELEVATOR.

[illegible] speciality of Messrs. Spencer & Co. (Ltd.), of Melksham, and the first design [illegible] from [illegible]. The most recent [illegible] machine is a modification [illegible] by Mr. A. H. Mitchell, engineer of the Port of London Authority, [illegible] Spencer. These latest machines have a remarkable flexibility and are generally [illegible]. The photographic view, Fig. 5, shows one of these elevators ready to be [illegible] into a grain vessel. The normal capacity of these elevators is 150 tons per hour, but they have handled more. When extended the telescopic elevator leg has a length of 44 ft., and it will close up to a length of only [illegible] ft. The endless chain of buckets is mounted in such a way that when the leg is to be lowered a corresponding amount of chain is paid out by means of a bight in the chain, so that it remains of constant length and at even tension. Motive power is supplied by a direct coupled electric motor of 10 B.H.P. at the head of the elevator, thus dispensing with driving chains. The elevator is suspended from the end of a cantilever jib, which is in turn carried on the top of a cantilever post; the post rotates on [illegible] carried on a turntable 16 ft. 6 in. above the deck.

The jib is provided with a conveyor band by which the grain is carried from the elevator to a shoot down the post, which discharges into swivelling shoots through the deck into a second (but stationary) elevator. These shoots automatically adjust themselves for every movement of the elevator leg. The canvas and rubber band is provided with diagonal ribs which prevent the grain from slipping back when the band is running uphill. The deck elevator will raise the grain to any required height, and drop it into a hopper from which it is weighed and delivered. The elevator is able, by an extensive range of motion, to work from a point 20 ft. 3 in. below the waterline, and it can also be lifted clear over the side of a steamer having 40 ft. freeboard. The electric energy is generated on board by a high-speed engine and suction gas plant. When out of use or when required for towing, the elevator can be turned right round and stowed over the top of the weigh-house.

A PORTABLE BUCKET ELEVATOR.

This is a modification of the Donald elevator conveyor to be described later, which can also be used for unloading cargoes of grain in bulk. It is an appliance almost identical with the standard machine, but with this difference, that instead of canvas "slings" steel buckets are employed; the chain of buckets can be lengthened or shortened in the same way by a bight in the chain, in order to accommodate itself to the cargo working. On the upper horizontal strand the steel buckets act like the scrapers of a push-plate conveyor, pushing the grain forward in a trough, and thus convey it on to the quayside into a hinged telescopic shoot which discharges into a hopper fitted with an automatic weighing and bagging machine. In the alternative method,

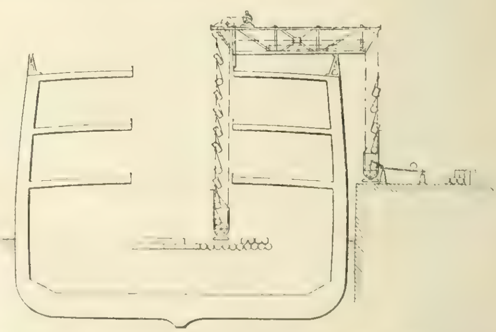


Fig. 6.—Diagrammatic View of Machine Unloading a Miscellaneous Cargo.

a smaller chain of buckets is led over a number of guide pulleys, in order to discharge immediately above the hold into a band conveyor. One of the guide pulleys forms the bight for taking up slack, and paying out chain corresponding with the depth of cargo in the vessel. In this case a band conveyor delivers at the quayside by telescopic shoot into a sacking apparatus.

If we make a comparison between the merits of the pneumatic system and of the bucket elevator we find that the former takes a little more power, but is more flexible, produces less dust in the holds, has no injurious effects on the health of the workers, no waste through spilling, and can be employed in all weather. With the bucket elevator the insertion into the hatches of such a rigid structure takes more time than that of the iron or compo flexible suction pipe of the pneumatic plant. It may be awkward with some vessels to get into the hold, as ties and bracings may impede the path of the elevator leg; worst of all, a large amount of trimming is necessary to get the last of the grain to the elevator, while with the pneumatic practically no trimming is required. We recently saw a case very much to the point. Oats were being unloaded from one of the very largest cargo steamers afloat in the docks at Liver-

pool, but with the construction of the holds in question, and the situation of the hatches—right under the captain's bridge—the only economical method of unloading was the pneumatic. In rough weather the suction pipe can be led into the hold without admitting the rain, while the bucket elevator cannot be so used without uncovering a larger area.

The pneumatic system, generally speaking, is more suitable where large cargoes from ocean-going steamers have to be dealt with in ports which regularly receive such cargo all the year round. In other cases the bucket elevator would be more economical. At the present time when labour is so scarce the pneumatic system is more particularly recommended on account of the depletion of the necessary labour for trimming. The rate of speed at which pneumatic plant works brings about a considerable reduction in the time taken to discharge a ship-load of grain; with the advantage, from the national point of view, that the ship is turned round and sent out again on a fresh voyage much more quickly, while the shipowner reaps the benefit in the shape of decreased charges for unloading and dock dues, and increased earning capacity of his ships.

Some fine work relating to the rapid discharge of grain cargoes was recently accomplished by the Port of London Authority, and reported in the "Docks' Gazette." The s.s. "Wimborne," with 6,908 tons of oats in bags and bulk, was discharged in the Millwall Dock in 36½ working hours; while the s.s. "Bronze Wings," with a similar cargo of 4,500 tons, was discharged in the same dock in 21 hours. In the Surrey Commercial Docks the s.s. "St. Quentin," with 7,1[illegible] tons of bulk wheat, was discharged in 35½ hours. In the Royal Victoria Dock the s.s. "Gramina," with [illegible] tons of wheat in bulk, was discharged in 41½ hours, an average of 21[illegible] tons an hour, one day's working of 11 hours resulting in no less than [illegible] tons being unloaded.

The Donald Portable Ship Elevator-Conveyor.

Having dealt somewhat with the bulk handling of our [illegible] bread, we will now consider the mechanical means by which the national larder is stocked with the rest of our goods. Antiquated methods unfortunately [illegible] have not yet been entirely superseded. Thus four men may be seen at the docks in the hold, who by their united efforts get [illegible] of [illegible] into a sling ready to be carried to the ship's winch. This way of doing it is to be deplored because it is based on a wrong principle, being intermittent. A load on a crane moves quickly when it is moved at all and is carried through the air, but the time is wasted by the men filling and emptying the slings and by the crane always having to return empty. If such freight is handled continuously it is always on the move in an unbroken sequence of packages, with no waiting of the men for each other. As all the rest of our food dealt with under this heading is in individual loads or in packages of some kind within the limit of 2 cwt. it can practically be handled by the same mechanical device, but in some cases modifications are necessary in order to adapt the containers to the cargo to be handled.

The Donald elevator-conveyor, built by Messrs. Rownson, Drew & Clydesdale (Ltd.), is designed for the specific purpose of loading in and out of ships piece-goods cargo of more or less uniform nature, and in units, the weight of which should, generally speaking, not exceed 2 cwt. This machine is most successfully in use for handling such cargo as frozen mutton, bananas in crates and loose, barrels, cases and bagged stuff, cheeses, &c., within the limits of the above weight. By changing the shape of the carriers the same machine can, as we have already seen, handle bulk goods, such as grain, nuts, &c., very satisfactorily.

The machine proper consists of a light structural steel frame, arranged to rest with one end on the hatch combing, and the other on the bulwark of the ship (*see* Fig. 6). The steel framing carries a series of rollers and gearing which support and operate the two endless chains carrying canvas "slings" between them in which the cargo is handled. These two chains are connected by cross-bars, which serve as distance pieces and keep the two chains permanently in their relative positions. The canvas "slings" are provided with a number of small [illegible] at each end by means of which they are attached to the cross-bars. The [illegible] of the canvas loops or "slings," as they are more frequently called, is [illegible] to the size of the objects the machine has to handle. [illegible] "sling" would be [illegible] but [illegible] that a 4 ft. "sling" will handle most general food cargo. The speed at which the [illegible] travels is [illegible] ft. per minute. The pitch of the "slings" [illegible] from 2 ft. 6 in. to 3 ft. [illegible] in keeping the [illegible] Fig. 7 represents such a machine with the [illegible] inside, the [illegible] and both the feed [illegible] and the discharge [illegible] up to their highest position, that is the position in which the machine is slung [illegible]. The [illegible] in such a way that [illegible] the hold, [illegible] the delivery [illegible] the [illegible] is to be [illegible]. The [illegible]

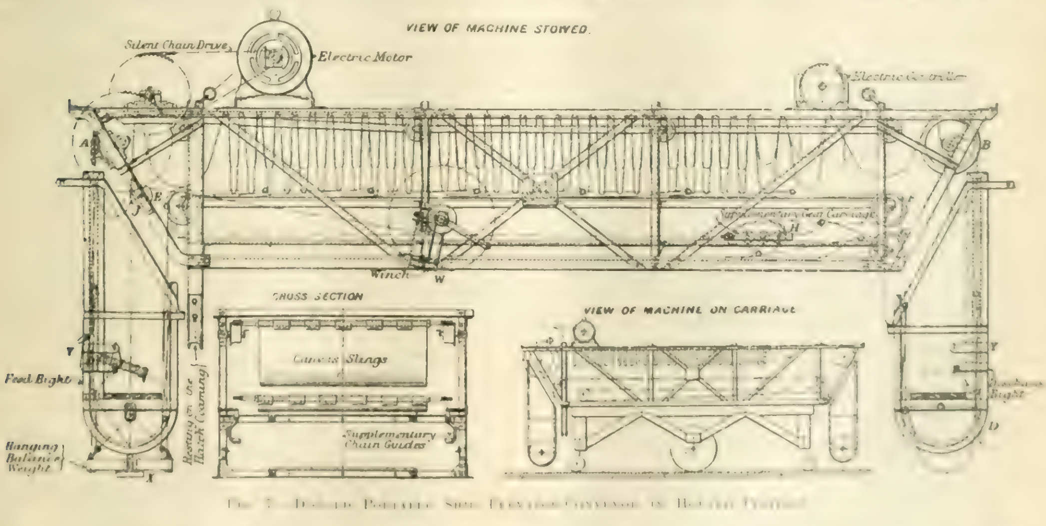


Fig. 7.—Donald Portable Ship Elevator-Conveyor [illegible]

lowered into the hold, and the balance weight (previously lowered) attached; the delivery terminal is next lowered also to where the goods are to be received. A normal machine is of such dimensions as to reach to the bottom of the hold of an average vessel and likewise down to the barge or dock level alongside. To overcome any difference occasioned by the alteration in the water level or the cargo working which alters the relative position between ship's deck and quay level, or the depth of the hold—in other words, to accommodate any portion of the conveyor chain not in use at any one time—a supplementary loop or bight is introduced into the chains. This takes the form of a pair of chain wheels *H*, mounted on a carriage and arranged to slide on a prescribed path, from one end of the frame to the other, by means of a rack-and-pinion motion controlled by a small hand winch (not shown) placed on one side of the steel framing. On the opposite side of the framing another hand winch *W* is placed, which adjusts the height of the hanging balance-weight *X* attached to the feed bight or terminal, and controls the length of the same. Such a machine can generally be driven by a 3 H.P. electro-motor, and the power is taken by flexible leads, either from the ship's supply, or from that of an adjacent warehouse. Such a machine as illustrated has an overall length of 22 ft., the "slings" are 4 ft. wide, the pitch of the "slings" is 2 ft. 6 in., and the approximate weight is 2 to $2\frac{1}{2}$ tons complete, so that in the majority of cases it can be safely handled by the ship's derrick.

Fig. 8.—Donald Elevator Conveyor Unloading a Cargo of Cheese.

The electro-motor may be seen on top of the machine; it is geared by a silent chain drive to a counter-shaft, which in turn drives by two pinions into two main wheels (one on each side), which give motion to two sprocket wheels *A*. The reason why there are two such chain drives for the two sprocket wheels *A* is that no driving spindle must connect the upper sprocket wheels, in order to leave a clear passage for the slings with their load. The two chain wheels *A* and the gear wheels which give them motion, are therefore mounted on two short lengths of spindle clear of the conveyor. The sprocket wheels *B* at the other end are similarly supported. The chains, as they proceed on the feeding bight when unloading a ship, pass over the pulleys *A* and *B* down to the delivery terminal *D*, and thence up over the guide-rollers *G*, *H* and *F*. As already mentioned *H* forms the auxiliary bight which takes in slack and pays out chain; from *F* the chain returns over *E* to the feeding bight again. This terminal with its balance-weight *X* is let down or pulled up by the hand-winch *W*, over the guide-pulley *J*; the cable supporting this weight divides at the lower end and is fastened to the two supporting shackles, whilst another strand of rope passes down over small rollers and up again at the other side. The slings and chains which are seen festooned along the upper surface of the frame are only in that position when the machine is housed.

Owing to the nature of the machine the two terminal bights cannot be rigidly connected with the upper portion; they are simply suspended by the conveyor chains and the wire cable. In the receiving and discharging positions two hooks may be seen; these are provided for a simple discharging device, which can be hooked on to either side of these hook attachments. The loading-in requires no special appliance, as a man simply lifts the load into a sling which passes sufficiently slowly to enable him to do so. A form of delivery device is shown at *Y*. When

Fig. 9.—Donald Elevator Conveyor at the Quayside. Unloading Tea.

the unloading operation is completed, the empty conveyor is allowed to run on, the discharging bight is now wound up by lengthening the auxiliary bight, so that it will reach again the housed position, shown on the drawing (Fig. 7), and as the feeding bight is wound up by the winch *W* the chain festoons itself automatically in the mild steel framing of the machine, and again assumes the position shown. Fig. 8 shows a photographic view of one of these unloaders discharging cheese.

An advantage of the system is its large capacity with the same number of men, small wear and tear, very little noise, and considerably less damage and breakage to the goods handled than with the ordinary method of unloading by means of cranes.

In addition to the portable form these machines are also built stationary or semi-stationary, fixed at the quayside; carried from a gantry with an extended jib, so that any vessel

can be plumbed (see Fig. 9) or att[illegible]ed to warehouses on the quay, in which case the machine is usually cantilevered from the top of a warehouse. Another similar installation is shown in Fig. 13. This form is more particularly applied to loading and unloading lighters and other small craft. A similar machine has been arranged for a cold store in London, handling carcases of mutton (see Fig. 10).

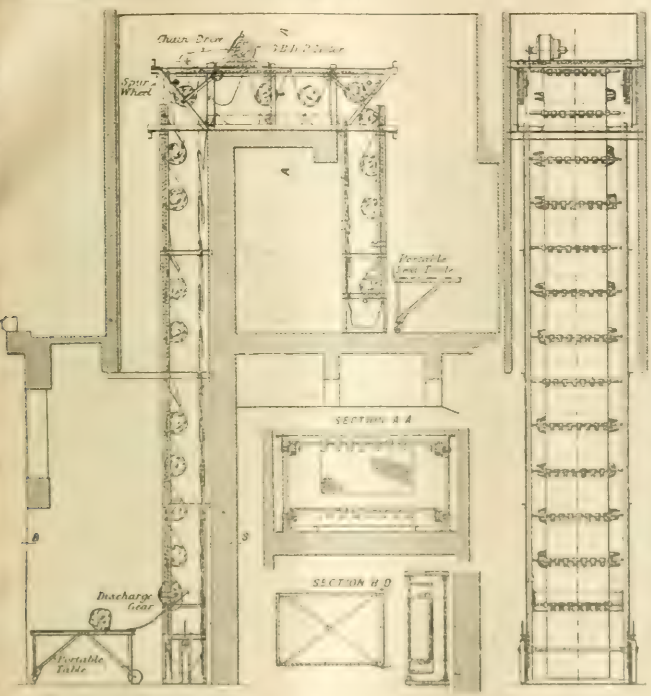
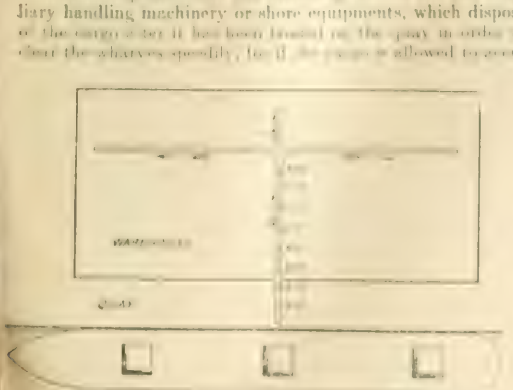


Fig. 10.—Donald Elevator Conveyor [illegible] Carcases of Mutton into a Cold Store.

Auxiliary Handling Machines

Next in importance to the unloading devices are the auxiliary handling machinery or shore equipments, which dispose of the cargo after it has been landed on the quay in order to clear the wharves speedily, [illegible] allowed to accu[illegible]



[illegible] 11.—Diagram [illegible]

[illegible] on the [illegible] the unloading machinery will have to [illegible] and the advantage of the elevator conveyor, which is working continuously, is thereby partly nullified.

Assuming that the goods are deposited by steady mechanical means in a continuous flow, they must be carried a stage further by the same even flow. Portable band conveyors or roller runways are used for this purpose, and some of these devices will be seen in the accompanying photographic views (Figs. 14 and 15). If we compare [illegible] with those of multitudes of casual labourers searching for "marks," and in time [illegible] truck to another dump, we realise at once the superiority of the machine.

Let us see, for instance, how the roller runway operates. Each package, as it is received from the ship, automatically continues its journey on the runway, at requisite intervals along the side of which men are stationed to divert the packages when necessary along their respective courses. These men are supervisors with intelligence, and not beasts of burden, and they are given a [illegible] pay, not starvation wages. Each man knows the "mark" he wants, he sees it coming along on the runway and knows where it has to go.

The accompanying diagram, Fig. 11, will elucidate the method employed. The roller runway starts exactly where the elevator conveyor deposits its load; the packages will then proceed by gravity along a slight incline. It is necessary to have a man to render a little [illegible] branches and to direct the packages [illegible] of the [illegible] ways. When the packages [illegible] the [illegible] they are taken off [illegible] take only those packages with specific "marks" and send them either to railway trucks by means of [illegible] tors to be stacked. Packages marked AB, CD, EF, GH for instance, will be diverted to the left, while those marked IJ, KL, MN will proceed to the right, and if goods of a "mark" not provided for come along they are sent straight on to the [illegible]. The packages travel at the rate of 60 ft. per minute, so that the man has ample time to recognise his mark and take the package off

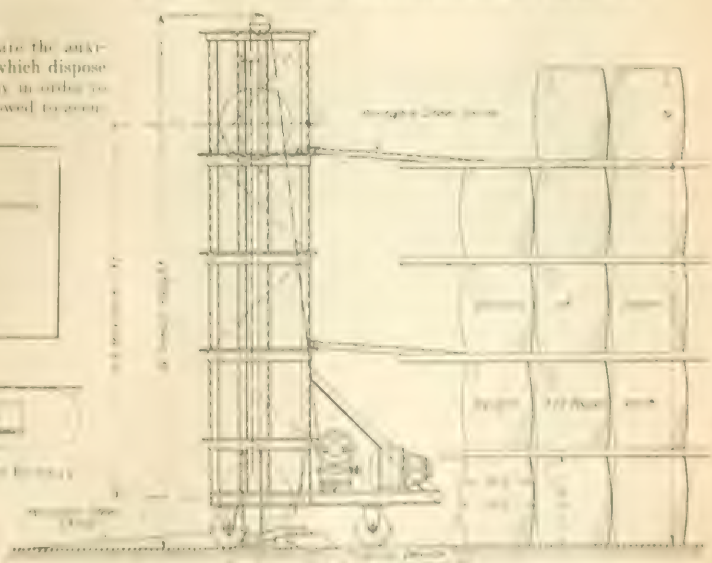


Fig. 12.—Portable Automatic [illegible] and Lowerer.

as it comes up. If the packages are 18 in. long and the conveyor will handle at the above rate of speed, 40 a minute will pass, and 40 men could not carry, much less maintain, the disposal of packages at such a speed. These figures are sufficient to show the importance and economy of these handling schemes by the machine as compared with hand labour.

Fig. 14.—Elevator Conveyor attached to a Warehouse.

The roller runways are also useful as sorting tables when arranged on a level. The goods may then be sorted and taken direct into waiting vehicles or transferred by the same continuous system to railway wagons, and, thirdly, by means of portable stacking machines into store. Fig. 14 shows the

Fig. 17.—Portable Stacking Machine for Bags.

stacking of bags of wheat. Whatever the predetermined route the freight has to take from the hold it is continuous without loss of time, labour and money.

Quarters of beef are the only articles of food which, on account of their weight, have to be lifted out of the hold by the old-fashioned tackle. The only reason why the Donald elevator cannot be used for this purpose is that such a machine for the purpose would be too heavy for the ship's tackle to lift into place. Four quarters of beef are generally raised in a sheet of tarpaulin, and when they reach the deck they are deposited on a portable band conveyor and handled out of ship. The way in which the beef is transferred from the band conveyor to the overhead runways is shown in Fig. 15. From one of these runways the beef is delivered to a large cold-storage warehouse. These runways are partly power-driven and partly automatic or pushed by hand. In the former case an endless chain engages simultaneously with the carriers and releases them again when power is no longer required. Mutton is similarly handled for transporting to the cold-storage, but without the use of the overhead runway, and Fig. 10 shows how it is elevated and then lowered into a cold-storage in

Fig. 15.—Handling Quarters of Beef, Showing on the Right the Band Conveyor, and on the Left the Ardee Runway.

London. All these machines for handling beef and mutton just described are manufactured by Rownson, Drew & Clydesdale. Pork is handled similarly to beef by appliances of the Chain Belt Engineering Co. The half-carcases are suspended on rollers from a mono rail and dragged along by an endless travelling chain.

By handling our food by machinery we achieve two important objects. We not only replenish our larder at a less cost,

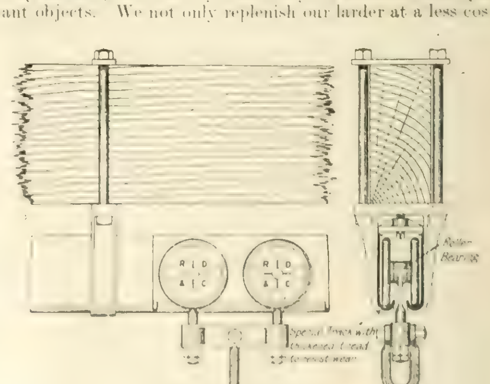


Fig. 16.—"Ardee" System of Overhead.

but we also liberate a large number of men for occupations more worthy of their intelligence.

Further information on the same subject may be found in "Engineering," November 24, 1916, the "Docks' Gazette," "Cassier's Engineering Monthly," and the "Merchant Service Review," to whom the author is indebted for some of the information given above. Figs. 7 and 10 are reproduced through the courtesy of "Engineering."

Economic Transport and its Influence on the Price of Everything.

By ALFRED WARWICK GATTIE.

Summary.—The author illustrates the importance of the [illegible] by analysing the [illegible] in the price of fish as sold by the retailer [illegible]. The latter price is about [illegible]d. per lb. [illegible]

ONLY a few years ago Sir Henry Trueman Wood, the secretary of the Royal Society of Arts, wrote to me that the reform of goods transport did not strike him as an attractive enterprise because the railways, "the only people interested," were against it. In expressing that opinion Sir Henry Trueman Wood undoubtedly voiced the general opinion then held. At that time (1911) the man, and, more important, the woman, in the street had not realised that on an average about half the cost of everything is made up of transport charges. Had they been asked whether the various articles of food exhibited in the retail tradesmen's shops, originated in those shops, they, one and all, would have replied with some asperity that the retailer bought them from the wholesaler; but at that point, even now, in the case of 99 per cent. of them, all knowledge of a definite character would [illegible].

They would, however, hotly dispute that transport charges could not possibly be as much as [illegible] the price of the article they had purchased. On reflection, [illegible] would concede that the delivery of goods at their doors from the premises of the retailer must "cost something," and the admission would be made in a tone which would show that they thought the "something" was quite a negligible factor. They will doubtless be astonished to learn that in the case of a large retailer, the cost of sending goods to his customers in London amounts to upwards of £50,000 per annum.

It is necessary to explain that [illegible] has to be added to the sale price of the articles sold by that retailer in order to recoup him for this expenditure; and it will thus be seen that the present cost of distributing goods as between retailer and consumer must, like all other charges, ultimately fall upon the consumer. It is therefore, [illegible] interest of the consumer to consider whether the present method is extravagant or not.

After so simple a point has been [illegible] explained one is always met with the reply that "it is obvious that the consumer must pay all charges incidental to the cost of the article he consumes." It is [illegible] when it is pointed out, but it is not present to the [illegible] of the ordinary individual. It is in the background of his consciousness and it is not given proper prominence in his calculations. I think [illegible] proved by the letter from Sir Henry Trueman Wood, who, I may assure the reader [illegible] a person of [illegible] intellect [illegible].

[illegible]

[illegible]

[illegible] of the proceedings, coarse fish may be bought at [illegible] per cwt. We now have to ask how it comes about that [illegible] fish costs [illegible] landed [illegible] to buy from the fishmongers in London? The answer to that question may be given in the one word "Transport."

It must not be understood that ample profits should not be allowed to those who carry on the business of distributing fish, but the question is whether this cost of distributing should amount to a 10,000 per cent. increase on the price of the fish landed and packed in ice on the quay at Hull.

Mr. Pibel tells us that the cost of carrying his shilling box of fish from Hull to Billingsgate will be 6s. 6d., and a further and varying charge for carrying the empty boxes from London. The cost of carrying these empties might amount to 3s. a cwt.

Delivered at Billingsgate the box of fish will have cost Mr. Pibel—

1 box of [illegible] lbs. at [illegible]	1s. 0d.
Transport to Billingsgate	6s. 6d.
Return of empties, say .	0s. 6d.
	8s. 0d.

So far it will be seen that the cost of transport amounts to seven times the cost of the fish landed on the quay.

That, however, is not the whole story.

The 6s. 6d. is a special low rate for coarse fish, and a higher sum is charged for carrying prime fish like soles. The extra charge is made on soles, though they may be carried in the same truck with the plaice. It is further to be remembered that these rates are [illegible]. That is to say, if Mr. Pibel's fish happens to be delayed en route, and arrives too late for the market, Mr. Pibel has to bear the loss. At this point the reader will no doubt say to himself that, at the outside, taking risk, and carriage, and market tolls, and all the rest of it, the cost price of a box of plaice at Billingsgate to Mr. Pibel cannot be more than 10s. or about ¾d. per lb. How comes it that he finds it necessary to charge 3d. per lb. to the retailer? That is a profit of 300 per cent. [illegible] than a reasonable profit, and that the apparent 300 per cent. is due to circumstances which are not fully known to me. All that can be said without any fear of contradiction is that [illegible]

[illegible] riage to Billingsgate is [illegible]d. per lb.; and the gross profits [illegible]

[illegible]

[illegible] it is, is always blocked with hundreds of railway vans, which [illegible] to the retailers' shop is, therefore, [illegible]

[illegible]

[illegible] on the price at which in pre-war days we were wont to see it marked for sale in London shops.

Turning to the figures, it would seem at first sight that the cost of transport (exclusive of delivery from the retailer to the consumer) is only responsible for $\frac{9}{14}$d. + $\frac{8}{14}$d. = $\frac{17}{14}$d., add another $\frac{11}{14}$d. for delivery to consumer, and we have $\frac{28}{14}$ = 2d., total transport charge on our sixpenny lb. of fish.

So it would appear, at first sight, but we have not got anything like the whole story. Examination of the figures reveals that on the cheapest classes of fish, Billingsgate, with a daily turnover of 800 tons of fish, was in pre-war days making a profit $\frac{31}{14}$d. per lb., and we may be reasonably sure a proportional sum is made on expensive fish. If we estimate the average gross profit at Billingsgate to be 6d. per lb. on 800 tons of fish we know that the total gross profits of this market amount to £44,800 per day, or for 300 working days in the year, £13,440,000.

"Yes, Billingsgate is evidently a very expensive place," [illegible] will say, "but what has Billingsgate to do with transport?" The answer is that Billingsgate is a by-product of inefficient transport. The retail fishmonger does not go to Billingsgate and waste hours there in the dark and twilight mornings because he likes it but because he must. He does [illegible] toll on the fish he buys from choice but from [illegible].

The first [illegible] the retail fishmonger is that he must have fish to sell. There must be no uncertainty about it. He [illegible] to be without his stock of fish and good fish if the man in the next street is able to supply it. He would [illegible] day's business, but he would lose his reputation [illegible] a far more serious matter. He goes to Billingsgate because he can rely on getting what there is to have, if he is willing to pay the price. If there should be a shortage of fish at Billingsgate, prices are raised, and those [illegible] pay get the fish, and it is sold at the enhanced price to the public. But in the case of a glut of fish in Billingsgate, though there will be a drop in prices, it will not [illegible] corresponding to the ordinary law of supply and demand.

[illegible] allowed to have cheap fish," is the [illegible] of Billingsgate. The price must be kept up; [illegible] of fish the price must be kept up until the fish is condemned as unfit for human food; and then [illegible] thrown into the [illegible] barges which always lie alongside the river front of the market. This once [illegible] taken away and thrown on to the land as manure. This I know of my own knowledge to be true.

The next question to answer is, why the retail fishmonger [illegible]

[illegible]

as the gross profits on it are £13,000,000 odd Billingsgate is quite content to remain wasteful and cumbrous and malodorous. Billingsgate is aware that it cannot hope to survive in the presence of an efficient system of transport, and it is therefore satisfied to pay the railways nearly £5 a ton for doing work which could easily be done under proper conditions for 5s.

But in dealing with fish consigned to a variety of consignees in small quantities, or comparatively small quantities, some organising ability is requisite, and that in railway circles is conspicuous by its absence. Bitter experience has taught the fishmonger that with fish consigned to him direct mysterious delays occur. No fish is delivered to him, and that day he can do no business. Then he gets a memorandum from the railway company to say that his fish was sent to the wrong station, and as there was nobody to claim it, it was thought best to sell it by Dutch auction among the railway officials to save it from going bad. The four boxes of fish had been sold for 12s. 8d., and the bill for carriage amounted to 26s., including return of empties. Would he therefore remit the balance due of 13s. 4d. Mr. Pibel does not quote actual figures on this point, and my figures are only used to illustrate the position with the necessary sharpness. The fishmonger has to pay for the fish the railway officials have eaten, and also a portion of the cost of carriage. After two or three such experiences we can quite understand why the retail fishmonger goes to Billingsgate.

Effect of Improved Conditions.

Billingsgate as it is now is one of the many expensive by-products of railway inefficiency, and under proper conditions, its follies, its filth, and its monstrous expense would disappear.

Fish would, under improved transport conditions, become a very cheap food. The first results of this change would be a greatly increased consumption of fish, and, necessarily, a greatly increased catch. By cutting the waste of money now involved in transport of fish, more money would be available to pay the fisherman, and the whole industry involved in getting the fish. This would be possible although the sale price of the fish were only a fraction of what it now is. On top of these two gains, the railways by abandoning their present wasteful methods could make a greater net profit on the work done, and at the same time pay their workmen a better wage. With regard to Billingsgate, the net profit on all useful work done would be greater than it now is. The readers of THE ELECTRICIAN will be familiar with the features of the proposed scheme of goods clearance with which my name is associated, and there will be no need to go into that matter here, but I may give a few details illustrating the proposal with regard to fish.

To begin with, there would be no need for the whole of the augmented supply for London and district to pass through Billingsgate. Under Clearing House conditions, fish packed in containers and sub-containers could be sent direct to the retail fishmonger via the Clearing House without any fear of non-delivery or delay, from the port of shipment.

Fish could also be sent direct to the consumer if that course was found to be desirable, but under the proposed improved conditions I imagine that dealing through the retailer would be the usual course adopted. With regard to Billingsgate itself, assuming that the market continued to do the same amount of business as at present the [illegible] tons of rail borne fish normally carted to it by [illegible] railway vans from the various London goods stations would be abolished, and the valuable space in the roads they now occupy for eight or ten hours per day would be free for the use of the retailer. It will be noted that this economy not only involves the saving of a double handling of the boxes when full and another double handling of the boxes when empty, but the abolition of these carts enables the retailer to come close up to the market and thus minimises the expensive porterage now required.

The method of conveying rail borne fish to Billingsgate under Clearing House conditions would be to run all fish [illegible] into the Clearing House.

the fish being carried in steel cage [illegible]. These containers would then be despatched to the [illegible] House wharf at Blackfriars, where they would be hoisted off the train and into a special barge. This barge will have brought the empty boxes from Billingsgate of the previous day's business, packed in their steel cage containers, and empty boxes will have been hoisted out of the barge and deposited (in container loads) into a suitable deodorising tank, where they would remain until required to be returned to the port of shipment, via the Clearing House by the returning empty [illegible].

Not only would this great economy be possible, but by bringing into being a wholesome competition with Billingsgate market, the shocking manœuvres by which the price of fish is kept up and this good food finally thrown away as manure, would become a scandal of the past. I have now shown how transport affects the price of fish. If the reader will realise, that in varying degrees, transport affects every trade and every occupation, and therefore the welfare of every man, woman, and child, my object in writing this article will have been achieved.

Examples of Electrically-Driven Cranes.

By H. H. BROUGHTON.

Summary.—The author points out [illegible] importance of [illegible] machinery [illegible]. [illegible] given of special plant for handling [illegible] plant including shipyard cranes, steel works cranes, and [illegible].

THE topsy-turvydom of to-day is apparent from the fact that, while skilled men ought to be urgently required in every sphere of human activity, the [illegible] are indispensable and, therefore, at a premium. If [illegible] times, it be profitable to use machinery for the handling of materials in countries where unskilled labour at less than sixpence per day is plentiful no argument is needed [illegible] that it must be even more profitable to use machinery in those countries in which unskilled labour is paid from [illegible] [illegible], and in which the said labour [illegible] organised as to be in a position to paralyse industry.

At the Engineering Conference in 1907 the late Sir William White said it had been obvious to him for many years that greater rapidity in dealing with cargoes [illegible] be the essence of success in commercial operations. This applies not only to dealing with cargoes but also and with equal force to the shipyard, to steelworks, to the factory, to the mine, and to every case where profit-earning depends on the speed and economy with which heavy material is handled. The enormous sums of money expended in recent years by harbour authorities, railway companies, shipbuilders and ironmasters on machinery for the handling of materials indicate the importance of the subject.

But there are still those who [illegible] the time occupied in discharging cargoes by [illegible] labour very freely, and this at a time [illegible] when all the available man-power is required for productive work. [illegible]

[illegible]

[illegible] with the year 1911 [illegible] been electrified. It will be seen that the maximum quantity of accumulated goods reached 540,000 tons in 1909, and only 300,000 tons in 1911. During the worst period of the year with the steam railway service a maximum of 80 per cent. and an average of 96·5 per cent. more goods were accumulated than with electric operation during a corresponding period.

Although the rapid discharging and distribution of cargoes happens to be one of the most important questions at the present time, it is not with the cargo-handling crane that we propose to deal. It is thought to be more profitable to give a number of examples of electrically-driven cranes applied to important industries, such as shipbuilding and steelmaking. Although the examples selected are of a striking character,

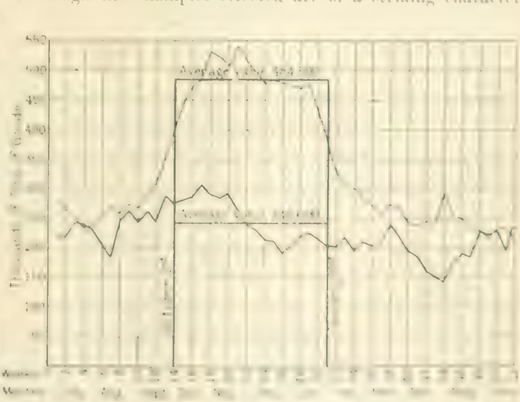


FIG. 1. [illegible]

it [illegible] examples [illegible]

SHIPYARD CRANES.

[illegible]

minimum interference.

[illegible]

A [illegible] of attention has been given to the economy of an efficient crane equipment over the building slips, and in this connection it may be noted that Mr. A. Murray estimates that there would always be economy in a good crane service that costs less than £8,600 per berth of a size suitable for building vessels of about 7,000 tons deadweight and about 400 ft. in length. In the case of larger vessels the saving in favour of cranes is greater in proportion on account of the heavier loads and the greater heights of lift.

One of the earliest of the modern systems is the cantilever crane equipment, and there are several noteworthy installations. One of these cranes is said to have placed in position in about 20 minutes a sternpost weighing 18 tons, taking it from trucks at the front end of the yard with but a few men—an operation which formerly took two or three days and which necessitated the employment of a large number of men.

A typical example is depicted in Fig. 2. The balanced double cantilever crane travels on an elevated gantry, 600 ft. long and 18 ft. wide, placed between two berths. There are also two side cantilever cranes for carrying the hydraulic riveting machines. The speeds of the main cantilever crane are: Travelling, 400 ft. to 600 ft. per minute; traversing, 100 ft. to 800 ft. per minute; lifting (5 tons), 200 ft. to 250 ft. per minute. Each of the [illegible] cranes is provided with two independent 10-ton travelling crabs having lifting, traversing and travelling motions.

Of more recent origin is the equipment consisting of a number of overhead travelling cranes [illegible]

[illegible] shows an elevation of the arrangement adopted by Messrs. Harland & Wolff for the construction of vessels of the largest size.

The structure, which has a total length of [illegible], consists of three rows of towers placed [illegible] apart longitudinally and [illegible] ft. transversely. These towers support longitudinal girders [illegible] at the top, which, in their turn, carry a track over the centre row of towers. On this track is mounted a cantilever crane which is able to travel the whole length of the structure.

A track is provided on the top of the longitudinal girders to carry travelling frames, which span across each berth. Each travelling frame contains two 10-ton travelling cranes. Another track is provided at the bottom of the longitudinal girders to carry 5-ton walking cranes. The rail level of the central track for the cantilever crane is 176 ft. above the ground level at the after end of the berths. The rail level for the travelling frames is 148ft. and for the walking cranes 118 ft. above ground level.

The cantilever crane is capable of lifting 3 tons at a radius of 135 ft., and 5 tons at a radius of 65 ft., and has lifting, racking, slewing and travelling motions. It commands a length of over 1,050 ft. and a width of 270 ft., and can lift or deposit material at any point within this area.

The six travelling frames, provided with 10-ton cranes within them, are for carrying the riveting machines. The internal travelling cranes have a longitudinal travel of about 35 ft., without the necessity of moving the frames. The frames at the after end of the berths have lifting eyes for dealing with stern frames, &c., weighing up to 40 tons each.

The 10 walking cranes are designed to lift 5 tons at a radius of 53 ft., and have lifting, slewing and travelling motions fitted to them.

The inside faces of all towers are fitted with a special arrangement to carry portable riveting or building platforms at any level and at any angle to suit the line of plating. Fixed sloping gangways are provided at the forward end of the berths, and are arranged to pass through the towers. Easy access is provided by them to any level up to the underside of the longitudinal girders. A complete system of stairs and gangways is provided throughout the structure, so that communication may be had to any part of the structure or to the cranes.

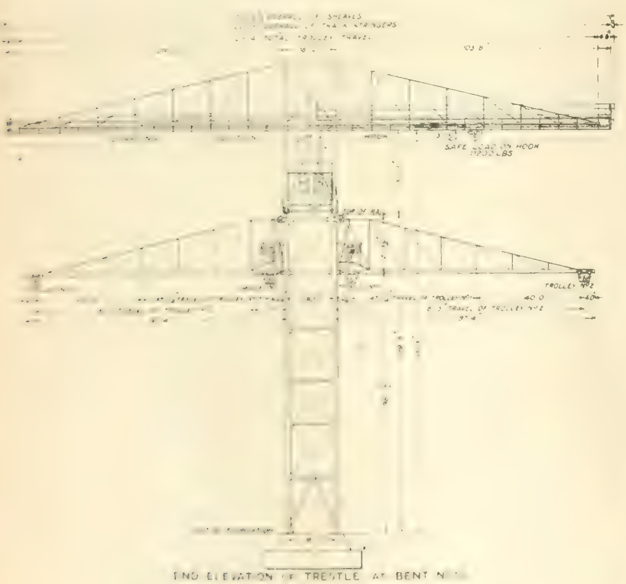


FIG. 2.—[illegible]

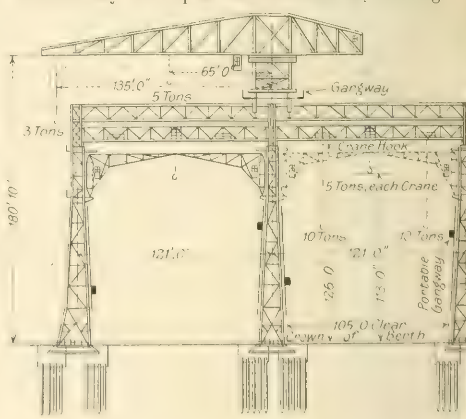


FIG. 3.—CRANE EQUIPMENT FOR SHIPBUILDING BERTHS.

The cranes were supplied by Messrs. Stothert & Pitt, and the whole equipment was undertaken by Sir William Arrol & Co. (Ltd.).

Fitting-out Basin Cranes.—Fixed cranes of the revolving cantilever type or floating cranes of considerable size are in use in various shipyards for the fitting out of vessels. Lifting capacities of 250 tons are not uncommon. In normal times the cost of a fixed crane of medium capacity may be £30,000. Four or five years ago no less than £170,000 was paid by the United States for the two floating cranes for the Panama Canal.

A good example of a fixed crane capable of dealing with a working load of 150 tons at a radius of 85 ft. is shown in Fig. 4.

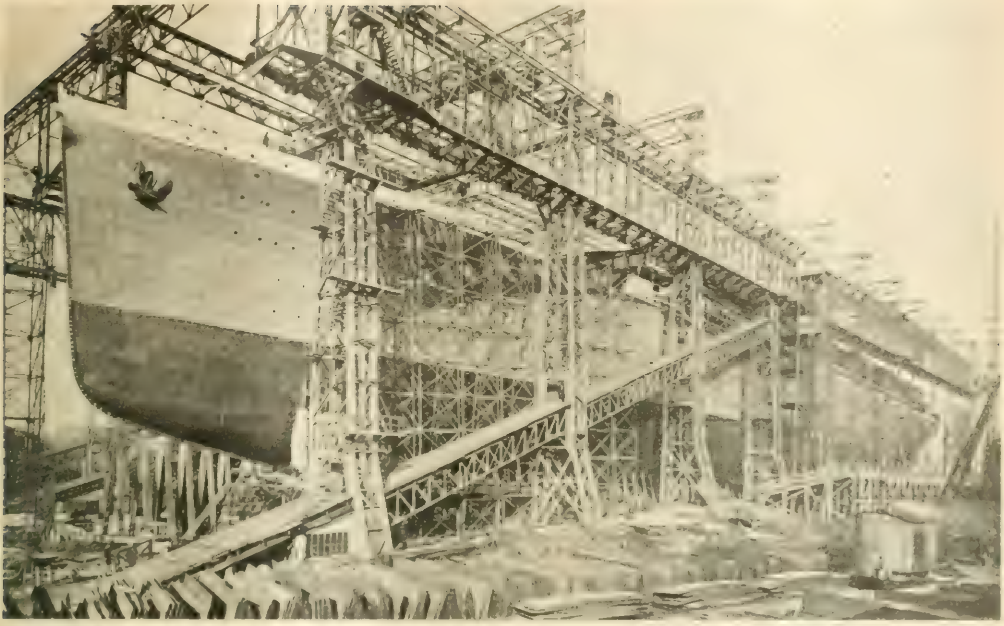


Fig. 4.—One of the Building Slips at Messrs. Harland & Wolff's, showing the "Britannic" [illegible]

The following are the principal particulars of a 200-ton crane of this type :—

Maximum load		200 tons
Test load		[illegible] tons
Working radii	200 tons	75 ft.
	180	82 ft.
	160	91 ft.
	140	102 ft.
	120	115 ft.
	100	133 ft.
	80	[illegible]
	[illegible]	161 ft.
Maximum height of load above quay		[illegible]
Height of lift		[illegible]
Minimum radius, auxiliary hoist		27 ft.
Travel of trolley	effective	134 ft.
	actual	197 ft.

Working Speeds.

Description	Load	Speed	Motors
Main hoist ...	200 tons	[illegible] per minute	[illegible]
...	100 ,,	10 ft.	
Light hoist ...	40 ,,	[illegible]	[illegible]
Racking ...	200 ,,	[illegible]	[illegible]
...	100 ,,	[illegible]	
Slewing	200 ,,	[illegible]	[illegible]
	100 ,,	[illegible]	
Wrap, lifting ...	[illegible]	[illegible] per minute	[illegible]
racking ...	[illegible]	[illegible]	[illegible]
[illegible] lifting	3	[illegible]	[illegible]
racking	3	[illegible]	

[illegible]

[illegible]

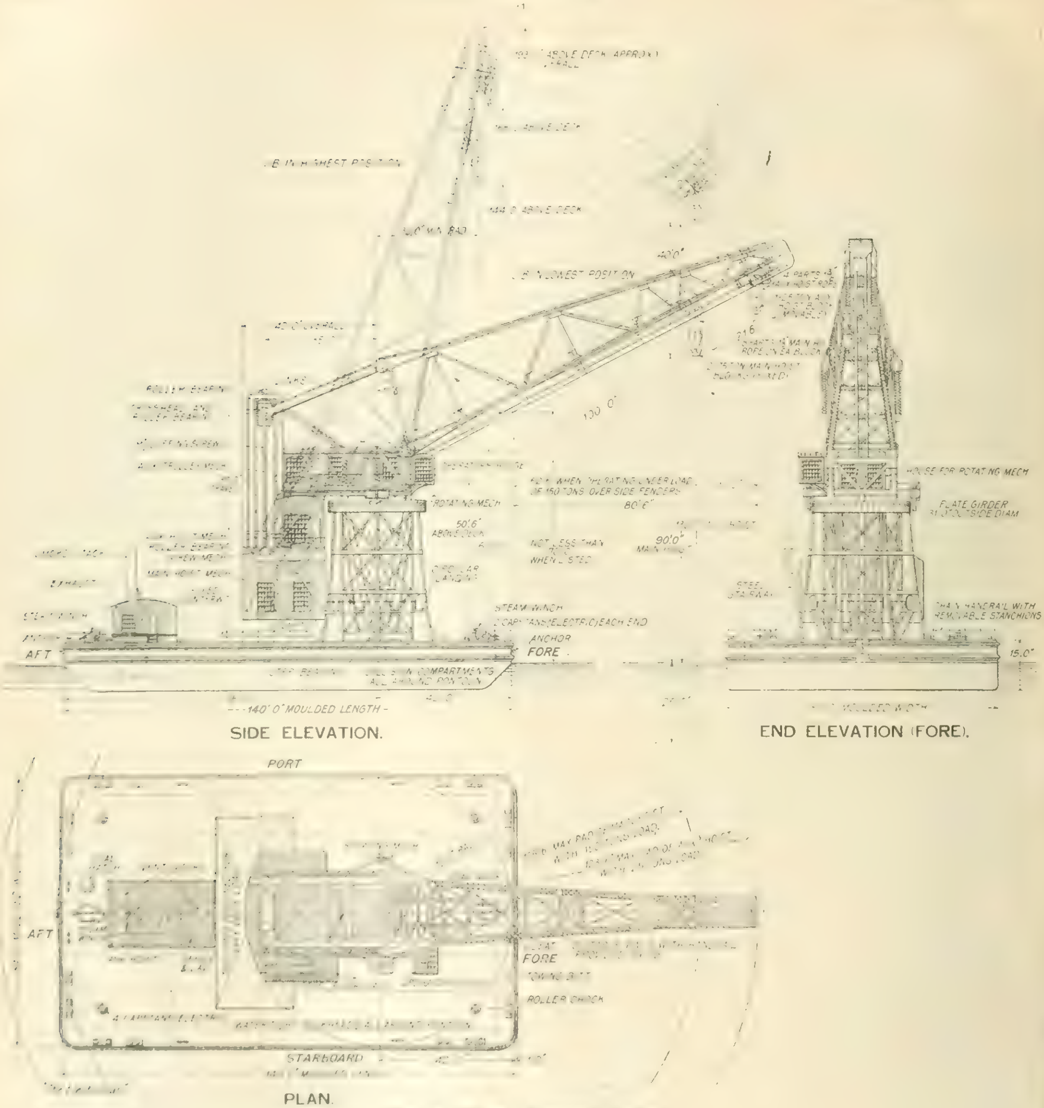


Fig. 6.—150-ton Floating Crane.

The floating revolving crane depicted in Fig. 6 was built by the Wellman-Seaver-Morgan Co. for the Norfolk Navy Yard (U.S.A.). It is electrically operated, power being supplied by a steam-driven continuous-current generator located in one of the compartments of the pontoon.

The crane is capable of lifting 150 tons at a maximum reach of 80 ft. 6 in. over the fenders. The 150-ton lift is accomplished by means of two 75-ton tackles, each capable of lowering a load vertically from a point 25 ft. below the surface of the water to 90 ft. above the water, making a total height of lift of 115 ft. In addition to the main hooks a 25-ton auxiliary hook is suspended from a trolley on the boom. This trolley travels on a runway suspended from the underside of the jib and is capable of travelling the entire length. The arrangement of the mechanism is such that the jib can be luffed under load from the maximum reach to the highest position, giving a minimum reach of approximately 52 ft. The crane is also capable of rotating under full load at the maximum radius.

All of the motors used in connection with the various mechanisms are of one size, and are provided with contactor-type control gear, the master controllers being located in the operator's cabin. Continuous current at a pressure of 250 volts is supplied by a 150 kw. dynamo, the latter being driven by a compound non-condensing engine.

The pontoon is of steel, and has the following moulded dimensions: Width, 85 ft.; length, 140 ft.; depth, 15 ft. Water-tight compartments extend entirely around the outside of the pontoon, and in addition to these compartments the pontoon is also provided with full-depth bulkheads to secure the necessary strength and rigidity.

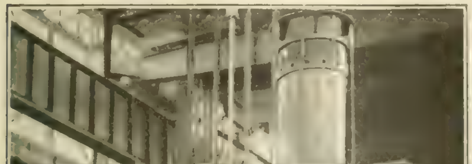
Steelworks Cranes.

Forge cranes, ladle cranes, charging machines, soaking pit and stripper cranes are examples of some of the labour-aiding appliances used in the manufacture of steel. They have come to this country partly from America and partly from the

Continent, and the designs have [illegible] modified to meet the home requirements. It is generally recognised that the service is unusually severe, and that [illegible] care must be taken to ensure continuity of service. In the beginning, breakdowns were often traceable to the use of [illegible] and improperly rated electrical machinery and apparatus. Motors and control gear designed specially for the purpose resulted in markedly improved performance.

Such gear, which is known briefly as mill-type, should always be used. It implies magnet-switch control for most of the motors, and certainly for all motors of large output, and it implies motors of a more robust construction than those met with in ordinary industrial service.

Forge Cranes.—Heavy forgings are manipulated under the hammer or press by an overhead travelling crane fitted with a telescopic gear for rotating the ingot. Such a crane, by the E. & H. Co., of Charleroi, is depicted in Fig. 7. The forging is supported in an endless chain running over a sprocket wheel, which is driven from a vertical shaft by means of gearing. The vertical telescopic shaft is supported on ball-bearings, and is provided with universal joints.

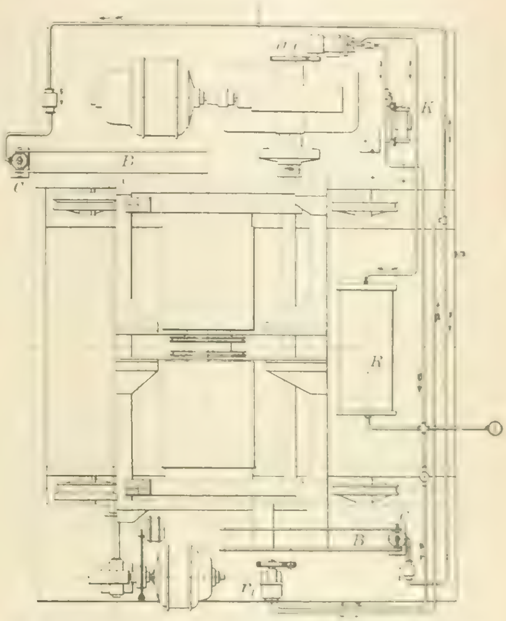


[illegible]

[illegible]

[illegible]

that the [illegible] duplex pneumatic brakes controlled from the operator's cabin, so as to maintain constant lowering speed. These brakes are sufficiently powerful to stop the maximum load (moving at a maximum speed) in a distance of about 20 in.



[illegible]

[illegible] pressor, *ac*, operated from the lifting mechanism. When the air pressure has reached a given value, a pressure-regulator, *r*, [illegible]

[illegible]

[illegible] conveying hot metal [illegible]

In cranes of this type the main trolley runs on a track formed on the top of the bridge girders, with chains or ropes hanging over the sides, and the auxiliary trolley runs between

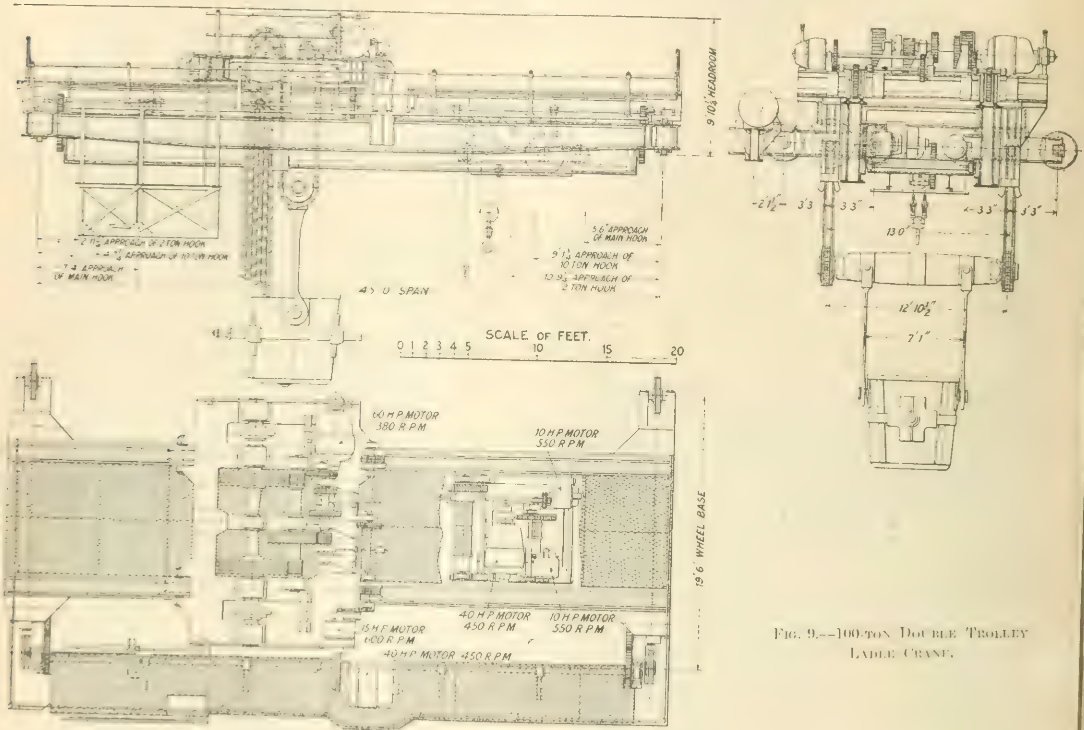


Fig. 9.—100-ton Double Trolley Ladle Crane.

the bridge girders on a track supported by the lower flange of the main girders. Cranes of large capacity are usually provided with an auxiliary trolley having two sets of lifting gear, the larger of which can be used for lifting a ladle load by the main hooks, or it can be used as a ladle crane itself, the light hoist being used for tilting the ladle.

Fig. 10.—Heavy Ladle Crane.

The crane depicted in Fig. 9 was designed and constructed by Broadbent & Sons, and although set to work more than 10 years ago it may still be regarded as a good example of a modern steelworks crane. It is of 100 tons capacity and 45ft. span. The main lifting mechanism is driven by a 60 H.P. motor, and is geared to give a full load lifting speed of about 5½ ft. per minute. Change speed gear is fitted which enables a load of 30 tons to be lifted at 17 ft. per minute. Traversing is effected by a 15 H.P. motor at 50 ft. per minute. The auxiliary trolley is provided with two lifting mechanisms, one of 10 tons and the other of 2 tons; the full load lifting speed being the same in each case, namely, 10 ft. per minute. Travelling of the entire crane is at the rate of 150 ft. per minute, and the mechanism is driven by a motor rated at 40 H.P.

Nowadays one seldom finds chains used for lifting purposes. The practice of carrying the hook cross-head between two strong steel guides depending from the trolley has been discontinued, as it has been found that the ordinary double rope arrangements are dependable.

A further example of heavy ladle crane, of Oerlikon manufacture, is shown in Fig. 10, and views of the main and auxiliary trolleys are given in Figs. 11 and 12. Two speed polyphase induction motors are used for lifting purposes, that on the main trolley being rated at 45 H.P., and giving speeds of 1 and 2 metres per minute for loads of 120 and 60 tons respectively. The lifting motor of 26 H.P. on the auxiliary trolley is geared to lift 25 tons at 3 metres per minute and 12½ tons at 6 metres per

minute. Speed changing by altering the number of poles is now fairly well known, and is a method to which the Oerlikon Company has given considerable attention. Ordinary induction motors are used for traversing and travelling.

Stripper Cranes.—Many of the improvements that have been made in these machines are due to the firm of Wellman, Seaver & Head, and one of their machines is depicted in Fig. 13.

Considerable pressure may have to be exerted in order to strip the mould from the ingot. The stripping gear consists of a motor, several reductions of spur gear and a barrel from which power is taken by steel wire ropes arranged in 12 parts reeved double, with two parts coiling right and left hand on the barrel. The ropes pull the tongs upwards until the ingot comes in contact with a stationary ram which forces it from the mould. To prevent undue load coming upon the stripping motor, the torque is transmitted through a slipping clutch on the second motion shaft.

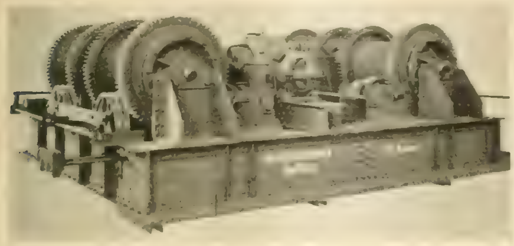


Fig. 11.—Main Trolley, 120 [illegible] Crane.

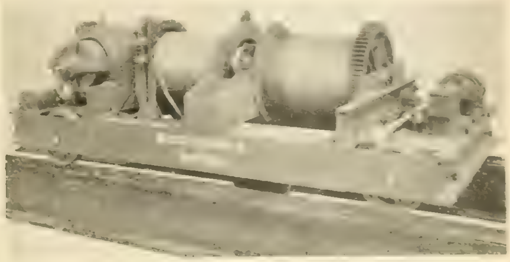


Fig. 12.—Auxiliary Trolley, [illegible] Crane.

Bridge Tramway Plant.—A [illegible] fast plant and bridge tramway for the unloading and storing of iron ore is depicted in Fig. 14. In this equipment the fast plant consists of four cranes, each of which is provided with a two-rope grab-bucket of 5 tons capacity. The bucket depends from a movable trolley, which can be racked through a distance of about 167 ft. on a track 40 ft. above ground level. The maximum outreach of the bucket from the dock wall is 44 ft., and the clearance line of the dumped bucket is 25 ft. above the ground. Sufficient clearance is provided to [illegible] the passage of live trains, and the [illegible] railway track as well as a storage [illegible] corresponds to 26 tons of ore per [illegible]. The buckets discharge either into movable weighing hoppers [illegible] above the tracks, or direct on to the storage pile.

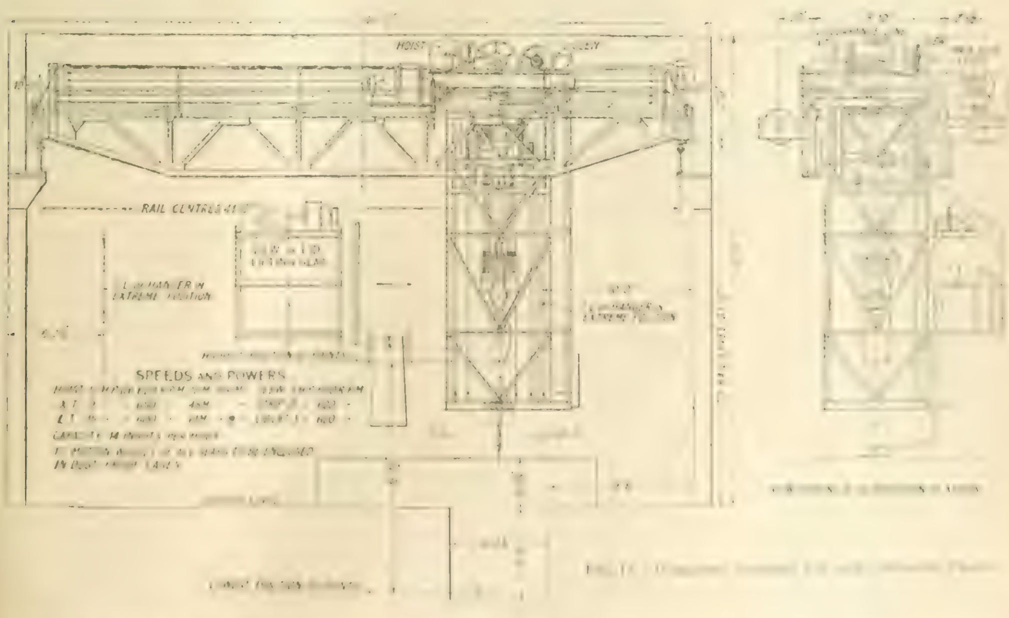
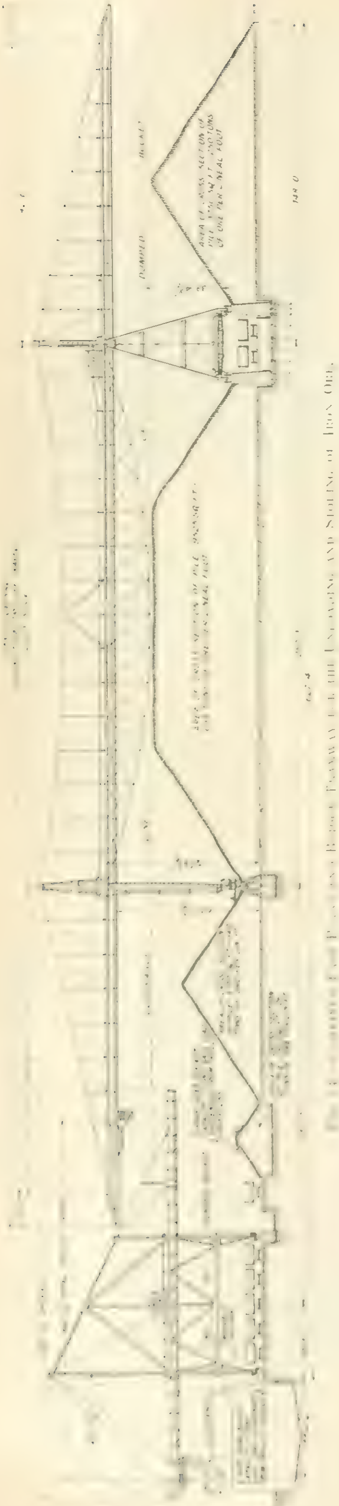


Fig. 14.—[illegible]

As the lower part of the gear contained within the cradle is rotatable, so that the tongs may pick up either ingot or mould irrespective of their position. The cage, situated at one side of the guide tower, is so placed as to enable the operator to obtain a clear view into the soaking pit. An interesting feature of the machine is the [illegible] lifting mechanism [illegible] the gear being clearly shown in Fig. 13.

The bridge tramway [illegible]



signed to give maximum strength with the smallest dead-weight, and area of material, with the members of such shapes and so arranged in the trusses as to expose the least possible surface to wind pressure. Hoisting is effected by a 7-ton two-rope grab-bucket, and arrangements are provided so as to enable the operator to turn the bucket through an angle of 90 degrees.

Readers of THE ELECTRICIAN will remember that several equipments of this kind for handling coal and iron ore were fully described some years ago.

In the foregoing we have described a few of the machines which have revolutionised manufacturing methods in two important industries. It is evident that many of these special machines are costly, and it is equally evident how greatly they must assist skilled labour.

Transfer Systems.

Where light loads have to be handled transfer systems of [illegible] ling hoist is gaining [illegible]

Fig. 16 [illegible] run off on to another crane bridge, B, over the north gallery, or on to the spur tracks, T_1, T_2, &c., in the south gallery. The spur track, T_1, runs to another building; T_2 and T_3 extend out over a railway siding; T_4 curves round and runs lengthwise of the south gallery; T_5 and T_6 run across the gallery. Hoists C, D, E and F are installed in the north and south bays under the gallery floors. Of these, C and D are each mounted on a travelling bridge, whilst E and F run on I beams lengthwise of the building.

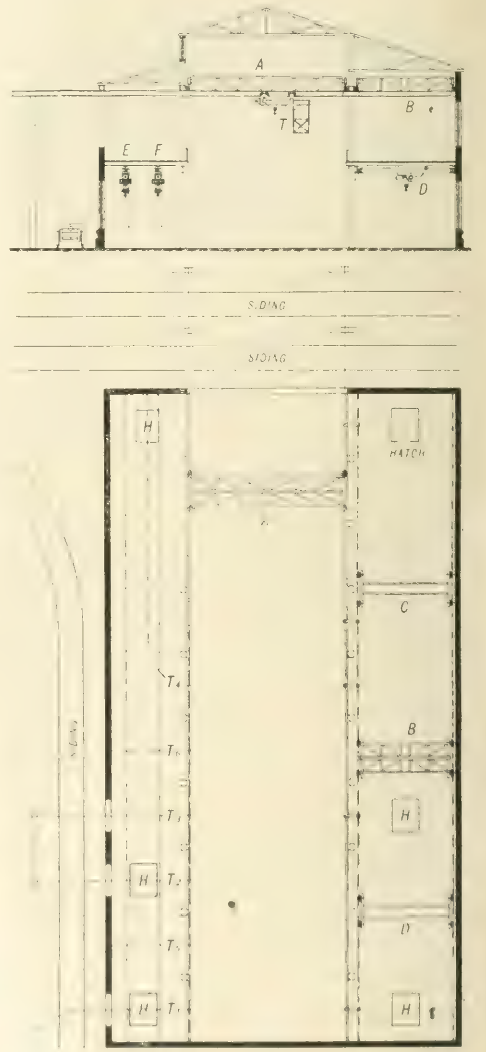


FIG. 16.—TRAVELLING SYSTEM OF ELECTRIC HOISTS.

Examples could be multiplied tenfold, but in concluding the author would observe that the same principle applies irrespective of the industry. Even to-day there are munition works in which the mere handling of the material costs between 30s. and [illegible] per ton, and many men are engaged all day and every day in [illegible] steel bars from wagons and lifting the said bars by means of a hand winch on to racks in the storage yard.

Notes on the Electric Equipment of Machinery for the Handling of Materials.

Summary.—In this article a number of points are discussed in regard to what may be termed [illegible]. These include motors, speed regulation, electric braking, controllers, resistors and switchgear.

THE crane and allied trades are peculiar in so far as a large proportion of the work calls for specialised knowledge outside the province of the crane maker or designer. As often as not the crane maker provides the details and assembles a large number of parts purchased from outside firms. Thus, the whole of the structural steelwork may be executed by one firm; the gearing by another; the ropes or chains by a third; the hooks by a fourth; the grabs by a fifth, and so on. It is not unusual for different firms to supply motors, controllers, brake-releasing electromagnets, lifting magnets, switchgear, safety appliances, and crane wiring material. In a word, finished parts are the raw materials of the crane trade, and this method of manufacture results in the user getting a reliable article at a low cost.

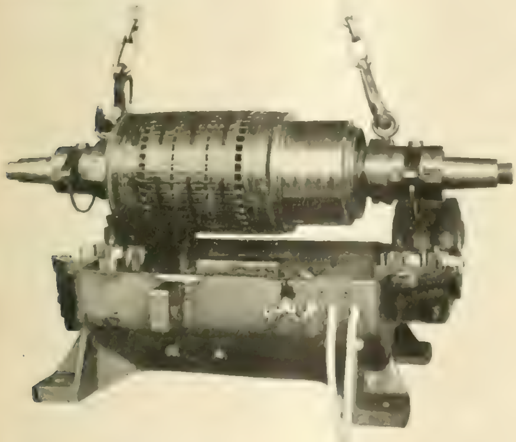


FIG. 1.—MILL TYPE D[illegible] MOTOR.

During the last decade a notable advance has been made in the design and construction of the electrical gear used for operating materials handling machinery, and the purpose of this article is to record the [illegible] and to give examples of modern methods. It should be mentioned that the article is intended more for the user than for the electrical expert.

MOTORS.

Structural Details.—[illegible] have been developed for the heavy engineering industries, as, for example, [illegible]. These mill-type motors, as they are called, [illegible] than ordinary motors. The principal features that have been [illegible] were set out by Mr. B. Wiley in a Paper read before the American Institute of Electrical Engineers about [illegible] years ago. Direct and [illegible] current machines [illegible] by the Westinghouse Company in accordance with the principles laid down by Mr. Wiley are illustrated in Figs. 1 to 3.

A prime [illegible] that all parts of a machine liable to wear or to break down shall be readily inspected and removed; and a machine so constructed that it does not admit of such ready inspection is faulty. The ease with which the vital parts of the mill-type motor can be inspected or removed is apparent from Figs. 1 and 2, and [illegible] characterised by their good design is evident from the sectional views, Fig. 3. If by mill-type is meant the best, we look forward to the time when all motors will, as a matter of course, be of the mill-type.

Interchangeability.—In order to reduce the stock of spares to a minimum the user should insist on the speeds of the driven machines or mechanisms being such as to call for a small number of different sizes of motors. As an example may be given a 40-ton travelling crane having a 10-ton auxiliary hoist. Travelling at the rate of 250 ft. per minute requires a 35 H.P. motor; hoisting a load of 40 tons at [illegible] ft. per minute requires a 35 H.P. motor; hoisting 10 tons at 35 ft. per minute requires a 35 H.P. motor; and for traversing at 75 ft. per minute a 7 H.P. motor is required.

Interchangeability applies not only to the motors, but also to the accessories. Although [illegible]

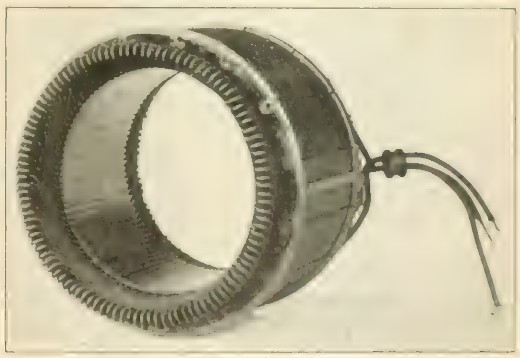


FIG. 2.—S[illegible] MOTOR.

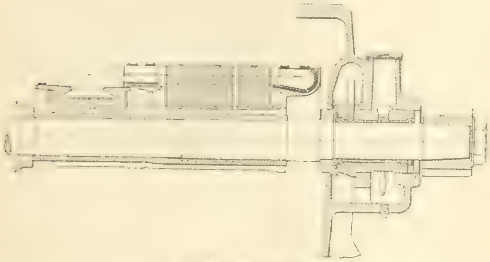
[illegible] (to take full advantage [illegible] of the fundamental properties of the electric motor), controllers of the same horsepower rating, nevertheless, have many interchangeable standard parts, [illegible] are interchangeable; and motor pinions and brake-gear for a given torque are interchangeable.

[illegible]

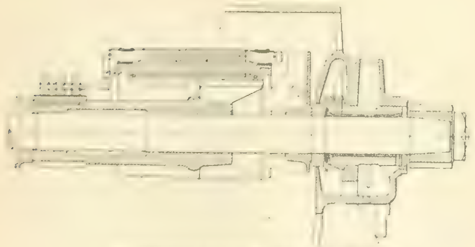
Rating.—[illegible]

[illegible] Apart from the necessity of keeping within the specified temperature limits, there are other points to be considered in the choice of motors, one of the most important being the speed. The fact that direct current series-wound motors run faster at low loads is very advantageous for the driving of lifting and hoisting mechanisms; but care must be taken to choose motors which will not run at excessive speeds [illegible]

[illegible] high-speed motors may be employed in cases where the no-load output is [illegible] below that at full load, as for example the travelling and traversing motions of a crane. But there are many instances in which it is preferable to employ low-speed motors. These have a powerful starting



[illegible] Direct-current Motor.



[illegible]

[illegible]

torque, they quickly acquire full speed, they can be rapidly braked, and in the case of [illegible] rope drums of large diameter can be used without an excessive amount of gearing. [illegible]

[illegible]

[illegible]

[illegible]

consumption motor would be considered. For the driving of cranes, hoists, elevators and the like, the choice generally rests between the direct-current motor and the alternating-current induction motor. From some points of view the latter are less suitable than the former; but, as we have said, simplicity is a strong talking point in favour of the induction motor.

Theoretically, the air-gap of an induction motor should be as small as possible, and the speed of the motor should be very high. Practically, the gap has to be made large, the speed small, and the ratio of starting torque to normal torque as large as possible. Large gaps and small speeds mean low power factors. We note with a good deal of satisfaction that some of the principal electrical manufacturing firms no longer lay undue stress on the importance of high power factor. Whilst not denying that high power may be of the utmost importance to the supply authority, we are, nevertheless, strongly of the opinion that it is no concern of the users whether the power factor is large or small. The user's point of view is that the motors do their work with reasonable efficiency for indefinite periods with little or no supervision. In this respect the low-speed large air-gap induction motor stands alone, and it is for the supply authority to improve the power factor. There are ways of doing so other than imposing irksome restrictions either on the user or manufacturer.

It can be shown that for a given duty induction motors may have to be more liberally rated than direct-current motors. A useful rule to remember is that for satisfactory service on a crane, or similar machine, an induction motor should be about 20 per cent. larger than a direct-current motor for the same duty. Thus, if the power required is 20 H.P., it is well to provide a motor rated at 24 H.P. in the case of alternating-current equipments.

SPEED REGULATION.

Direct-current Motors.—There are four methods of regulating the speed of a direct-current motor. These are rheostatic control by varying the resistance in series with the armature; voltage control by varying the line or supply voltage; field control by varying strength of the magnetic field; changing the number of turns in series on armature. The method last named involves double windings and two commutators (or two motors), the said windings being connected either in series or parallel.

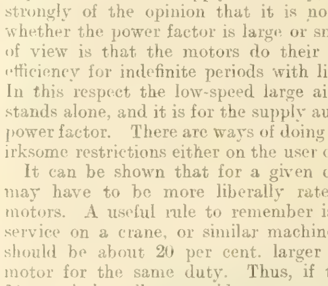


FIG. 4.—PERFORMANCE CURVES OF WOUND ROTOR INDUCTION MOTOR.

Of these, rheostatic control is usual for motors of small and medium size; and the running speed depends on the load as well as on the resistance in series with the armature. Voltage control may be accomplished in several ways, but for hoists, tips and such like machinery the Ward Leonard system is [illegible] approved. This system shows to the best advantage [illegible] the starting and stopping periods [illegible] large proportion of the running time, and when the [illegible] to be controlled are of considerable size. The Ward Leonard system is unrivalled where delicate control over a wide range of speed is desired. Field control is usually employed when it is desired to obtain speeds higher than the normal [illegible] the field strength is increased in order to reduce the speed below the normal.

[illegible] Motors.—The four methods of varying the speed of an induction motor are:

(1) By varying the resistance of the rotor circuits.

(2) By changing the number of poles.

(3) By [illegible] or cascade connection of two motors.

(4) By altering the frequency of the supply.

Of these, the first mention[illegible] the method generally adopted; the second and third [illegible] are limited to from two to four speeds, and the fourth [illegible] requires a separate alternator for each motor, and [illegible] it can seldom be used.

To illustrate the effect of [illegible] the resistance of the rotor, the group of curves depicted in Fig. 4 has been prepared. These curves show that for a definite rotor resistance slight variations of load result in considerable changes of speed. The said changes of speed are greater the higher the resistance of the rotor; and, at no load, the speed [illegible] practically coincides with the [illegible] of the motor.

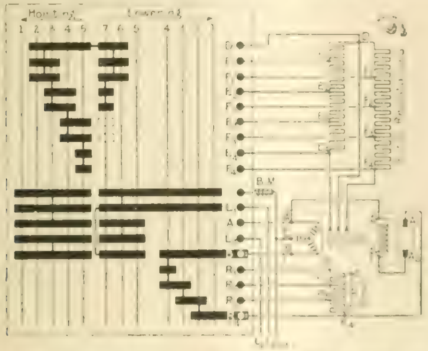


FIG. [illegible] DIAGRAM OF CONNECTIONS [illegible] MOTOR CONTROLLER [illegible] LOWERING SIDE.

It will be noted that the maximum [illegible] independent of the resistance in the rotor circuit, and that [illegible] the resistance changes the slip at which the torque is a maximum.

ELECTRIC BRAKING.

Direct-current Motors.—A[illegible] machine capable of transforming electrical into mechanical energy [illegible] mechanical into electrical energy. If, therefore, by suitable arrangement of the control [illegible]

[illegible]

Alternating-current Motors.—[illegible] electrically in three ways:—

(i.) Above synchronism by regenerative control.

(ii.) At any speed with direct current primary excitation.

(iii.) By counter current.

Of these, the first is based on the well-known fact that an induction motor, if driven by mechanical torque above synchronous speed, will be converted into a generator without change of connections. Braking by regenerative control is rarely used except for traction purposes, and in this connection the subject has been dealt with exhaustively by Mr. R. E. Hellmund.* The second and third methods, which have been fully discussed by Mr. Hellmund,† by Dr. E. Rosenberg,‡ and by Mr. H. C. Specht,§ [illegible]

Braking with Direct Current.—[illegible] braking effect the direct-current supply is connected to the stator winding, and the three slip-rings of the rotor are connected to a variable resistance. Such an arrangement represents an alternating-current generator with stationary field and rotating polyphase armature, the latter being connected to the rheostat. The speed can be controlled by varying either the resistance or the excitation.

There are three important limitations to the usefulness of the method. These are:—

[illegible]

[illegible] to such an extent that the load will fall if it happens to be a hoisting load subject to gravity.

[illegible] on coal and ore handling equipments, and it has also been used to some extent on the Continent. In Fig. 5 is given the development of a controller arranged for this method of braking.

Braking by Counter Current.—[illegible] induction motor for values of slip between 0 and 2 without [illegible]

[illegible]

[illegible]

The Control of Motors Operating Transportation Machinery.

By T. G. TRAVIS.

Synopsis.—The author deals in general terms with contactor control, more particularly with switchgear for cranes, transporters, live roll trains, furnace and wagon hoists and conveyor systems.

As a whole, the control of electrically-operated transportation machinery requires greater consideration from the designer than any other class of electric motor control gear. The main reason for this is probably the fact that, in general the transport of materials is merely an incidental to the process of manufacture, and as a consequence only cheap labour can be employed. Secondly, the time occupied in moving materials must be reduced to the minimum, and high

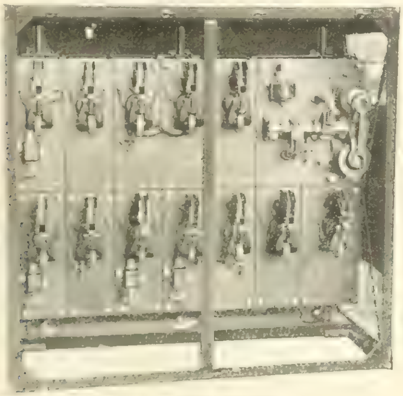


Fig. 1.—Contactor Panel.

speeds are as a consequence demanded, with the result that delays have been very serious losses. Thirdly, and as a result of the above, the control of such machinery should be absolutely fool-proof, and in many cases, such as continuous conveyor systems, must be entirely automatic.

The more recent development of electric motor control gear [illegible] considered itself admirably to the above require-

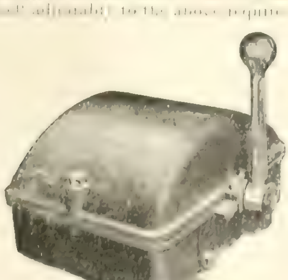


Fig. 2.—Master Controller. Fig. 3.—Master Controller.

The most exacting conditions of control are those demanded of motors operating steel mill drives, such as cranes, roll trains and furnace chargers. The control of furnace and wagon hoists where floor level stopping with varying loads is required also present special problems to the designer, and generally every system of belt conveyors presents its own problem in the interlocking of successive conveyors to prevent "dumping" of the material when starting up and stopping.

Cranes and Transporters controlled by contactor control gear can be arranged to eliminate all possibility of abuse. The rate of acceleration, the application of the dynamic brake for lowering and reverse torque for "plugging" can all be controlled automatically and set to operate at any desired point, *not by the operator* but by the skilled authorised attendant whose interest is continuity of operation. In some cases extra slow speeds are required. These may be obtained by the use of a shunting resistance connected across the armature. The minimum speed obtainable on a series motor with such an arrangement is from 5 per cent. of normal full load speed at full load torque, and by shunting the series field in a similar manner speeds up to 25 per cent. above normal with full load torque can be obtained. The controllers can be arranged to apply a dynamic brake automatically when the master controller is in the "off" position or on failure of voltage. Figs. 1 and 2 show a contactor control panel and master controller providing the features of power hoisting with slow speeds, dynamic brake lowering and dynamic braking for the "off" position for a 80 H.P. crane hoisting motion on 220 volts direct-current.

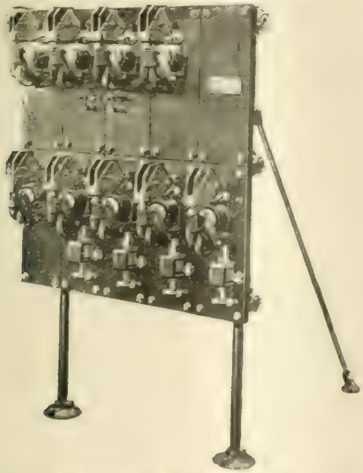
Fig. 4. Contactor Panel.

Furnace Chargers.—The manner in which furnace chargers are usually handled by the operators is quite sufficient proof of the necessity for some form of control gear which will keep the stresses imposed on the motors within safe limits. Contactor control will supply all this and at the same time leave the operator ample margin for quick and exact handling.

Power "forward and reverse" is in general all that is required with possibly dynamic braking in the "off" position to provide quick stopping. The master controller in general need only have two points on either side of the "off" position, one a slow speed point for adjusting, giving 15 per cent. to 25 per cent. of full speed and a full speed point. Such a master controller is very small and is shown in Fig. 3. This class of master controller may also be used for the traverse or travel motions of cranes and transporters where two points of control usually provide all that is required.

Fig. 4 shows the class of contactor panel which meets the requirements outlined. One of the difficulties which is frequently met in the case of furnace chargers is the provision of sufficient room for the contactor panels on the charger. This can be generally overcome by fixing the contactor panels on the frame-work above the operator. This incidentally places them out of his reach.

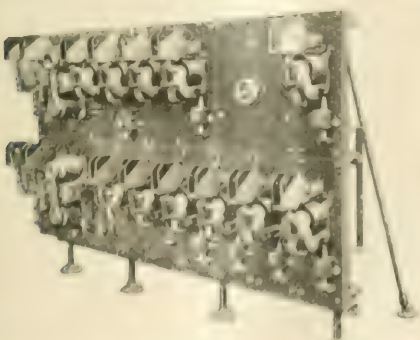
Live Roll Trains.—Where the control of live roll trains is effected by drum controllers it is no infrequent occurrence for the controller fingers and drum [illegible] to be changed twice a week. This was the case in a drive on which a contactor controller was recently installed of the type illustrated in Fig. 5. The contactor controller has run without any attention under exactly the same conditions for the last 15 months. There have been no renewals of contacts, and furthermore no stripped pinions on the roll train or burnt-out armatures during this period. Under the old conditions [illegible] were fortnightly occurrences.



[illegible]

The control provided for these [illegible] for furnace chargers but without the [illegible] braking, and with three points in each direction on the master controller. These three points give

1. [illegible]



[illegible]

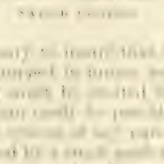
[illegible]

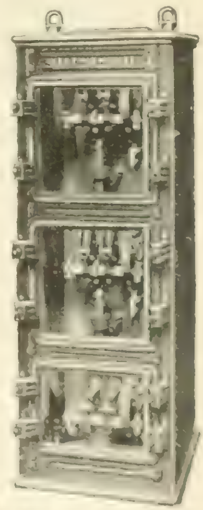
necessary for this class of drive under the old conditions. Blast furnace charging demands continuous operation in order to keep the stock level constant in the furnace, and any serious interruption in charging will mean a reduction of the unmelted protecting layer at the top of the furnace, resulting in the charging bell and top gear being burned, even if the furnace is not blown out. In some cases, and particularly with wagon hoists, accurate stopping is absolutely essential, [illegible] varying load in the buckets or cage.

Fig. 6 shows a direct-current furnace charging controller for a compound-wound motor.

The operating speed is adjustable and set by the field regulator hand-wheel shown. Dynamic braking for a final dead stop is provided, and level stopping is provided by a series of four limit switches at each end of the travel. The first switch operates at, say, 10 ft. from the end and reduces the speed by 25 per cent. The second switch operates a few feet beyond this and reduces the speed to 50 per cent. The final switch operates right at the end of the travel and stops the motor by dynamic brake from 25 per cent. of full speed. Thus very accurate stopping is obtained without any sudden jerks. The master controller used is again similar to Fig. 3 with two points on each side giving a slow 25 per cent. speed and full speed.

Conveyor Systems.—This class of drive is generally unlike all the above in that it is continuous running at full speed and non-reversing, consequently the starting and stopping can be controlled by a simple push-button switch as shown in Fig. 7. Where the conveyor system consists of a series of separate conveyors, each operated by a separate motor, however, it is





[illegible]

[illegible]

The Modern Cargo Crane.

By CLAUDE M. TOPLIS.

[illegible]. The relative advantages of the electric, steam and hydraulic types of crane are first outlined and typical designs are briefly given. For the handling of cargoes, speed is of first importance, and therefore this desideratum is borne in mind in the equipment that is provided. Details are described for giving the various motions—hoisting, slewing and luffing—and reference is made to the wear of ropes.

THE term "cargo crane" is generally understood to refer to cranes handling every kind of seaborne goods, excepting principally coal and coke, ores and grain. Practically every other class of article is, to a greater or lesser extent, dealt with by cargo cranes. The nature of the goods includes an infinite variety of qualities, from durable hardware, such as steel sections as used for structural work, to fragile and perishable foodstuffs, such as eggs, &c. A large quantity of these goods has, therefore, to be handled very carefully, and it is essential that goods of all classes should be handled expeditiously and economically. In peace times it is of the utmost importance that a cargo should be discharged or loaded in the least possible time, as the capital value of the ship is practically lying idle during these operations; but particularly during the present crisis, rapidity of action is an unquestionable necessity.

The total annual value in pounds sterling of the exports plus imports of the United Kingdom in 1913 was approximately £[illegible], and was the largest total of all the great manufacturing countries of the world, and if pounds sterling could be conveniently converted into lbs. avoirdupois it can well be imagined that the grand total would be something stupendous. Nevertheless, the weight of goods corresponding to the above value, whatever it may be, is annually handled at the ports of the United Kingdom, and a very large portion of it is dealt with by cargo cranes. A little speculative reasoning will, therefore, give one some slight physical conception of the enormous amount of work performed by cargo cranes throughout the country, and when we contemplate that a large percentage of the necessary commodities of life are imported into this country, their importance and influence as a factor in our national existence will be realised. Owing to our extensive navigable seaboard, plentiful ports and a pre-war preponderance of ocean-carrying ships, it is probable that the number of cargo cranes in this country [illegible] that in any other country of the world, and as the overwhelming majority of these cranes have been designed and built at home we have had ample opportunity to study the requirements and to develop the design to an extent which should enable us to defy foreign competition.

[illegible] years ago, when the application of electricity had not yet extended to anything approaching the limits it has to-day, the whole of the cargo cranes in this country were operated either by steam, hydraulic or hand power, the latter being of small importance relative to steam and hydraulic power. I believe it was in 1892 that the first electrically-driven crane was built for [illegible], and proved to be so successful in practice that users began to seriously consider this type in competition with the then existing steam, hydraulic and hand operated types.

[illegible] are as follows:

(a) [illegible] the steam crane, coal has to be taken to the cranes and hoisted up to the crane bunkers frequently, as the capacity of the latter are usually small, and often require replenishing. Water has also to be pumped or hauled up to the boiler, and, as the latter may commonly be 20 ft. above dock level, a small force pump is desirable and often provided for this purpose.

(b) The speed control of an electric motor is much more sensitive and easy to govern than that of a steam engine, and there are fewer handles to work.

(c) The machinery cabin in the case of the electric crane can be kept much cleaner.

(d) Less attention required, as there are no steam piping and packings requiring attention, no boiler fires to light, and oiling is not so extensive, the electric motor bearings being self-oiling.

(e) Much cooler in hot weather, and much quieter, thus enabling the operator to hear instructions when necessary.

(f) The machinery generally becomes simplified, the motor being a simpler mechanical prime mover.

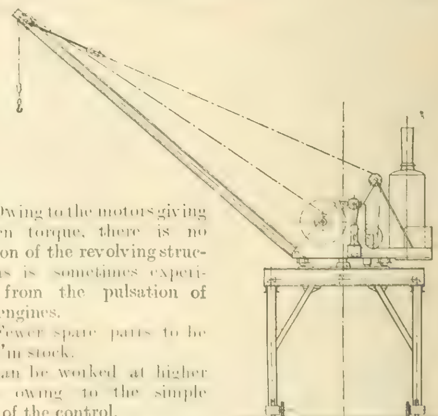


Fig. 1.

(g) Owing to the motors giving an even torque, there is no vibration of the revolving structure, as is sometimes experienced from the pulsation of steam engines.

(h) Fewer spare parts to be carried in stock.

(i) Can be worked at higher speeds, owing to the simple nature of the control.

On the other hand, there are cases where a crane is required in an isolated area, and under these circumstances the steam crane becomes particularly suitable, as by virtue of generating its own power supply it becomes a self-contained unit.

As far as I know, there are no costs of working for steam cranes available for comparison with the electric crane, so that definite figures regarding economy cannot be given; but it is clear that where power is generated on a large scale with efficient boilers, machinery and fuel handling plant, &c., the cost of power production must inevitably be much less than when it is generated under the necessarily inefficient conditions which apply to a steam crane boiler, even after making due allowance for the conversion losses from mechanical to electrical power.

Fig. 1 shows a typical steam crane suitable for cargo handling, and the following short description may be of interest: The superstructure would consist of mild steel or cast-iron side cheeks, having the machinery between them and extending backwards to provide a platform on which are placed the boiler, coal bunker and feed water tank. The necessary ballast would be fixed below the boiler platform, as far back as [illegible]. The foot of the jib would be supported between the cheeks at the front. The whole of the superstructure would

revolve around a mild steel post securely fixed into a bed in the top of the gantry, the weight being carried by two front and two back rollers, which run on a circular turned path; this is usually provided with an internally toothed wheel, in which the pinion of the slewing gear works. The boiler would be of the vertical type, provided with two or more cross tubes and fitted with the usual fittings; in some cases the boiler is lagged, but this is not always the case. The steam at 80 lb. or 100 lb. pressure would be taken from the top of the boiler to two steam cylinders, one on either side of the side cheeks. One of these cylinders is generally provided with a pump worked from the cross-head, which automatically pumps water from the tank into the boiler whilst the engines are running; if not so provided, a separate donkey pump or injector will be necessary. In many cases an injector is placed on the boiler as well as one or other of the pumps. The engines drive both ends of a cross shaft, which runs across the centre of the crane, and which contains the pinions and clutches for the hoisting, derricking, slewing and travelling gears. The exact arrangement of these varies according to the maker, but the approximate positions of the hoist and derrick barrels are shown in the figure. The travelling is done by means of a shaft passing down through the post and then by means of bevel gearing and shafting to the axles under the gantry.

ADVANTAGES OF THE ELECTRIC CRANE.

The principal advantages of the electric crane as against the hydraulic crane are as follows:—

(*a*) Simplicity and reliability of the transmission of the power from the station to the crane site. The electric mains are laid in most cases underground and require little attention, but in the case of the hydraulic mains there is always the possibility and actual occurrence of trouble due to frost or moving ground.

(*b*) The travelling of an electric cargo crane is performed by the simple operation of working the travelling motor controller, whereas in the case of the hydraulic crane, when it is necessary to move the crane from one position to another to suit the various ships' holds, the operation is one involving manual labour, owing to the fact that hydraulic cranes are usually provided with hand operated travelling motion.

(*c*) The electric crane can slew round continuously in one direction, whereas the hydraulic crane has only a limited movement in one direction before it is necessary to slew in the opposite direction.

(*d*) In the electric crane a minimum of power is consumed in lifting the empty hook or light loads, whereas in the hydraulic crane, even with compound cylinders, it is clearly not possible to regulate the consumption to correspond exactly to the load.

(*e*) Electric power is more economical in cost of working.

On the credit side of the hydraulic crane, however, may be mentioned the simplicity of the mechanical gear, the ease with which it can be controlled, and the efficient [illegible] braking system of the hydraulic [illegible].

In substantiation of the remark made in [illegible] may be mentioned the experiments carried out by Mr. Vincent L. Raven (now Sir Vincent L. Raven) at M[illegible] Dock with the object of comparing the cost of the hydraulic and electric systems as applied to dock-side plant. The results of these experiments are given in a Paper read at the [illegible] meeting, May and June, 1911, of the [illegible] Society of Mechanical Engineers. These experiments [illegible] character, and it was found that the cost of performing 1,000 foot-tons of work by means of the hydraulic crane was 1s. 6d., the time occupied being [illegible] hours. [illegible] the same work was later performed by the electric crane, and the cost per 1,000 foot-tons was found to be [illegible], and the time occupied 5¼ hours. It was stated in the [illegible] mentioned Paper that the total saving effected by the electric crane, including crane men and [illegible], was [illegible] per cent., but the load factor for the electric crane was only [illegible] per cent., as against [illegible] per cent. for the hydraulic crane, so that if more cranes had been working, better results would have been obtained for the electric crane, and it was estimated that a total gain as high as 50 per cent. would have been realised. The author also stated that the hydraulic crane was of an up-to-date design and provided with three vertical cylinders for lifting, and was overhauled by the makers and in perfect condition before the trials were made.

A typical design of hydraulic crane is shown in Fig. 2, to which the following description refers: This figure shows a fixed jib which is very common in this type of crane, also hand travelling gear at each corner of the plated-in gantry. It will be seen that hoisting is effected by passing a chain or rope which is anchored to the body of the hoisting cylinder, over pulleys at the head of the ram, then around pulleys at the foot of the cylinder and thence to the jib head, so that, when pressure is applied in the cylinder, the ram rises, taking up the chain and so lifting the hook, the height of lift being determined by the length of stroke of the cylinder and the number of times the chain or rope passes over the ram head. Slewing is effected by two cylinders fixed to the gantry on either side of a drum which is fixed to the bottom of the mast. A chain is anchored to each cylinder, passed over a pulley on the ram head and then back to the drum, around which it is wound a sufficient amount to enable the revolving part of the mast to make one complete revolution. It will be obvious that by admitting water to one cylinder and opening the valve to empty the other, the one ram will be pushed out, and so uncoil chain from the drum which it is pulling around, whilst the other is being pulled in through its chain being coiled on to the drum. A cast iron balance weight is provided on a back arm attached to the mast, equal in moment to about half the moment of the weight lifted by the crane. The hydraulic crane is usually worked at a pressure of 700–750 lb. per sq. in.

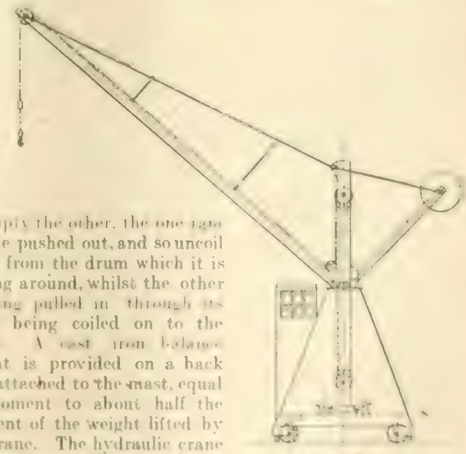


FIG. 2.

Having now briefly enumerated the relative advantages of the electric cargo crane as compared with hand, steam, or hydraulic cranes, an analysis and description of a thoroughly modern electric cargo crane may be of interest.

Figs. 3–10 show in outline a number of types of cranes as used for different local conditions. The various types are required on wharves depending upon the space available. On modern wharves which have been laid out to suit the conditions prevailing [illegible] those in Figs. 3–5 might be used, [illegible] make the gantry sufficient for a [illegible] railway tracks.

Referring to these separately, Fig. 3 shows a modern type of high gantry crane with a light lattice gantry, made of angles, [illegible] and capable of travelling on four [illegible] wheels along the wharf. The gantry is [illegible] by a [illegible] which revolves on a live ring of steel rollers and [illegible] in position by a centre pin fixed in the centre of the gantry, and through which the main cable [illegible] current to the upper part of the crane. The [illegible] is covered with a [illegible] and provided with separate motors for driving the [illegible] hoisting, slewing and derricking. Fig. 4 shows a [illegible]

superstructure contains a mast which is pivoted just above the portal, and revolving on rollers which engage in a horizontal circular path turned in the top of the gantry; otherwise the crane is similar to that shown in Fig. 3. Fig. 5 shows another type of fixed jib wharf crane. In this case no great

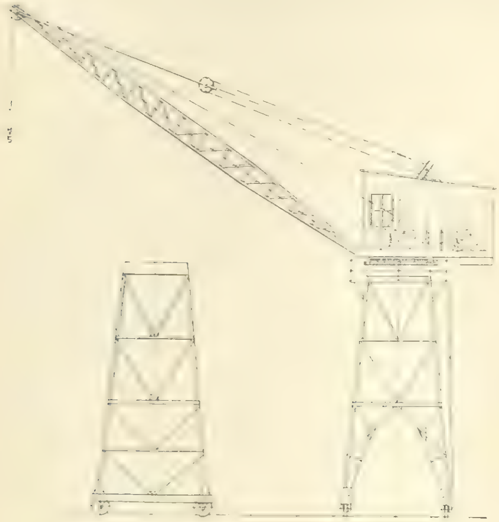


FIG. 3.

height of lift is required, and the jib is therefore kept as low as possible. The gantry for this crane consists of main plate web girders supported on legs made of rolled steel joists or channels. This crane is shown mounted on ground wheels for travelling, but whether a crane is made fixed or capable of travelling depends, of course, entirely upon the nature of

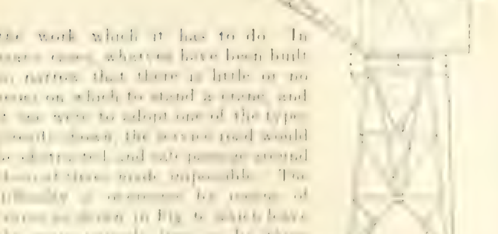


FIG. 4.

the work which it has to do. In many cases wharves have been built so narrow that there is little or no room on which to stand a crane, and if one were to adopt one of the types [illegible] shown, the service road would be obstructed and safe passage around them at times made impossible. This difficulty is overcome by means of cranes as shown in Fig. 6, which leave the quay entirely free, or by those shown in Figs. 7, 8, which offer little obstruction. Fig. 6 shows a [illegible] crane on a [illegible] track. This makes a very neat and serviceable crane when the [illegible] is of a sufficiently heavy construction to carry the loads imposed on it by the crane. Fig. 7 shows a semi-portal crane in which the front leg runs on the wharf, leaving the [illegible] free for traffic. The superstructure is mounted on the truck part of the gantry and revolves on a live ring of rollers similar to that in Fig. 5. Fig. 8 shows another type of semi-portal gantry on which a low truck crane travels. This type enables the hook to cover a bigger range with a crane of shorter radius, but is a rather heavier and more expensive crane. Fig. 9 shows a wall crane which is quite a common form of crane, and is often used on buildings with little or no wharf between them and the water. A transporter crane is shown in Fig. 10, which, by standing well back from the water's edge, leaves the space available for a railroad to run between it and the edge of the wharf.

Types 3 and 4 are, perhaps, the most common forms of cargo crane as used in this country. The capacity of cargo cranes varies from 1 ton to 5 tons; the most frequently used cranes have capacities of either $1\frac{1}{2}$ tons, 3 tons or 5 tons. The radius

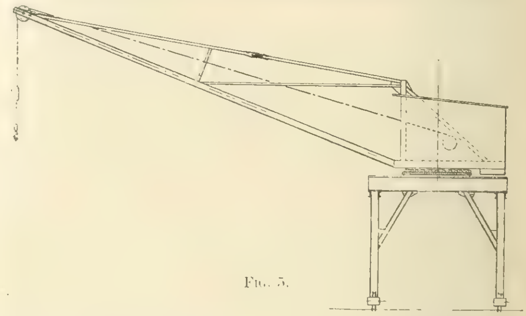


FIG. 5.

usually varies from about 35 ft. to 60 ft. As mentioned early in this article, rapidity of action for a cargo crane is absolutely essential, and the typical speeds of the various motions may be taken to be as follows :—

	$1\frac{1}{2}$-ton crane. Ft. per min.	3-ton crane. Ft. per min.	5 ton crane. Ft. per min.
Hoisting	250	150	100
Slewing	600	500	400
Luffing	150	120	100
Travelling	75	75	75

The 5-ton cranes should be fitted with a change gear in order to lift the lighter loads at a higher speed; but in the case of the $1\frac{1}{2}$ ton, and probably the 3-ton crane, it is problematical whether there is any advantage to be obtained by introducing this complication, as with a direct-current circuit and a series

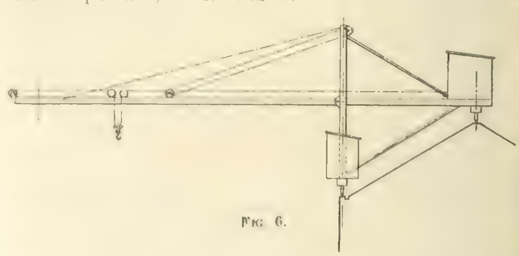


FIG. 6.

motor the latter will speed up with light loads to some considerable extent, depending on the nature of its characteristic curve. In the case of an alternating current circuit it may be desirable to fit a change gear to a crane having a capacity of 5 tons only, as clearly no increase in speed can be obtained with an induction motor. The lifting gear of a modern cargo crane should undoubtedly lift on a single fall of rope, even when dealing with loads as high as 5 tons, as the handling of a snatch block in the hold of a vessel is a clumsy and aggravating process, and is strongly objected to by stevedores and labourers. The lifting rope should be of steel wire of extra flexible quality, and the barrel should have machined spiral grooves. The gearing generally may be of cast iron or steel, the former usually being good enough for the purpose; but it will generally be found advantageous to make the motor pinion of raw hide

or similar material, as if this is not done the noise may become objectionable owing to the high peripheral velocity at which the teeth are moving. There are, of course, other methods which may be employed for reducing noise, such as the adoption of worm gears, helical gears or spur gears running in oil baths; but up to the present these systems have proved costly, and, although good results can undoubtedly be obtained with them, the results hardly justify the expense.

THE FREE BARREL.

A most important provision on the hoisting motion is a free barrel, and the advantages to be obtained from this arrangement are so great for cargo handling that no modern crane of small capacity should be without one. The ideal free barrel should have the clutch fitted actually on the barrel itself, so that when this is out of gear the barrel is absolutely free and under the control of a brake secured to the barrel. A partially free barrel which when revolving is rotating one or more pairs of gears is not satisfactory, as, apart from the incessant wear which is taking place, there is always the accompanying noise, both of which are serious disadvantages. With a free barrel of an ideal type the loads can be lowered out at any speed whatever consistent with safety, and would, of course, vary in accordance with the loads that were being handled, as it is obvious that an operator would lower a 5-cwt. load at a much higher speed than if he were handling a 3-ton load. It is probably inadvisable to lower loads exceeding 3 tons on a free-barrel, and, indeed, it is unnecessary, as loads in excess of 3 tons should always be lowered carefully out of consideration for safety alone, if for no other reason; it must, however, be remembered that cargo cranes are very frequently handling loads much below their capacity, and often as low as 10 cwt. or 15 cwt., and the advantages to be obtained from the free-barrel as regards saving of time under these conditions are enormous. An ideal arrangement for a 5-ton cargo crane is one in which the barrel may be fixed or free as desired. If a cargo crane is of the fixed barrel type, there is the danger of lowering out at an excessive speed and bursting the armature of the motor; and, moreover, with this type of crane power is often constant attention, as it will repay the driver in saving of time and personal comfort a hundredfold. The comfort of the operator is greatly increased by having a smooth acting brake, as for long periods of duty the strain when working a sticky or jerky brake is exceedingly trying. Brake linings, whether of wood or other material, should be frequently lubricated either with oil or dry graphite, the latter, in the writer's opinion, being preferable in many cases, as the brake is not so sensitive to the amount of graphite applied as it is in the case of lubri-

FIG. 9.

cating oil; that is to say, the coefficient of friction appears to be more constant when varying amounts of graphite are applied than is the case when varying amounts of lubricating oil are applied. Two common forms of braking are in use, one being the "brake on" system, and the other the "brake off" system. In the former case the pedal is depressed to apply the brake, and in the latter, the pedal is depressed to release the brake. Advantages can be claimed for both systems, but two important advantages for the "braking on" system are as follows: By far the greater number of brakes on cranes or other machines

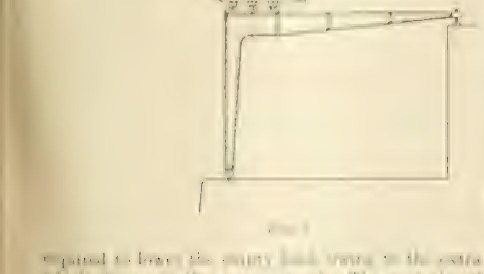


FIG. 7.

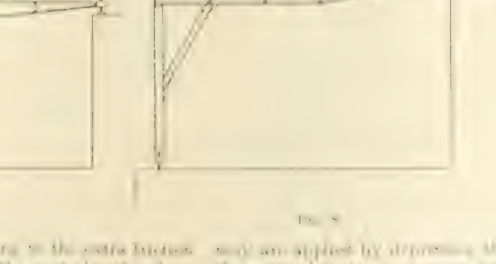


FIG. 8.

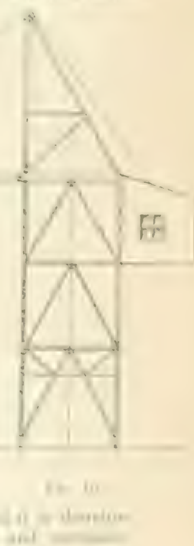


FIG. 10.

required to lower the empty hook owing to the extra friction which obtains in this arrangement. The control with a free barrel is greatly improved, as the load is very responsive to the action of the brake owing to the small inertia of the moving parts which have to be brought to rest. It is, however, an essential condition of a free-barrel crane to have a thoroughly satisfactory clutch, [illegible] [illegible] [illegible] worked. The brake on the free barrel should [illegible] be operated by a foot pedal, and in order to obtain [illegible] working and quick [illegible] generally, the brake should have

[illegible] are applied by depressing the pedal, and it is therefore the natural motion [illegible] generally to push down a pedal to apply a brake, and in case of emergency, if this action were carried out with the "braking off" system, a serious accident would [illegible]. Another great advantage of the "braking on" system is that [illegible] having worn and [illegible] the [illegible]

ciently important in the writer's opinion, to justify the universal adoption of the "braking on" system, but, in any case, it would be a fatal mistake to introduce the two systems on cranes in the same docks or worked by the same drivers.

With a fixed barrel crane such as may be used for a 5-ton load, rheostatic braking is a very reliable system, having the advantage of being easy to work, and being able to obtain different lowering speeds according to the controlling point in use. With rheostatic braking it is usually necessary to have one or more points on the controller which give power to the motor in order to be able to lower out the empty hook, and this introduces the possibility of the operator passing on to the power notch with a heavy load, in which case an excessive speed may be reached, and consequently the motor armature damaged; but this is a remote contingency, and could only occur due to carelessness on the part of the operator. Viewed from all points, rheostatic braking for lowering comparatively heavy loads when worked in conjunction with a solenoid brake on the motor spindle for definitely holding the load has much to recommend it, and is a system which is now extensively used in this country. Unfortunately this system of braking cannot be adopted when the power supply is alternating current, as although an induction motor will not greatly exceed its synchronous speed when revolving under the action of gravity owing to the negative slip producing a braking action, there is no satisfactory commercial system which gives a braking effect at all comparable to the rheostatic effect as used on a direct-current system. In the case of alternating-current systems it is therefore necessary to provide a mechanical brake for lowering the loads, but this does not prohibit the use of a solenoid brake in addition, as the latter can be energised on the first notch of the controller, and held off whilst the mechanical brake is in operation. It is usual to put an overwinding safety device on the hoisting gear.

The slewing gear of a modern cargo crane is generally operated through worm gear, and such an arrangement gives a very smooth and silent action. Owing to the high slewing speeds at which cargo cranes usually work, and the rapidity at which it is necessary to accelerate and retard the revolving structure, the inertia effect on the gears and shafts, particularly with long radius cranes, require careful consideration from the designer's point of view, and for this reason it is usual to provide a slipping clutch at some point in the train of gear. These slipping clutches are designed to take all normal drives and to slip in the case of any attempt to deal with an abnormal torque, thus relieving the gear throughout of shocks due to inertia, acceleration, &c.

The Luffing Motion.

A modern cargo crane should certainly be fitted with a luffing or derricking motion, in order to vary the radius of the jib when required and also to transport loads in a radial direction from the centre of the crane. Some years ago, Continental opinion was in favour of cranes having a fixed radius, but in later years this opinion has become more in favour of luffing motions on cranes until to-day it is quite a usual provision. In this respect it is satisfactory to note that British manufacturers may be considered to be ahead of their Continental rivals. The Continental method of luffing is usually by means of screws, whereas the common British method is by means of ropes. The former system which involves the use of a slow threaded screw is usually a very slow motion and exceedingly inefficient, whereas with the British method a high speed can be obtained with thoroughly efficient results. There is nothing of particular importance about the design of a luffing motion except that it may be mentioned that it was usual for some time to operate this motion through a worm reduction gear in order to prevent the possibility of the jib taking charge and running out, but this method had the disadvantage of introducing a very inefficient gear. A modern luffing motion must be considered to be composed of a highly efficient gear combined with a highly efficient braking system. The old form of luffing involving a slow motion and the lifting of the load and jib during the operation is now quite superseded by the modern method of horizontal luffing in combination with a balanced jib. Although this method has only been in use for 7 or 8 years it has met with surprisingly successful results, and no cargo crane could be considered to be of an up-to-date design unless it were provided with a horizontal luffing motion and balanced jib. This system has many advantages, two important ones being the high efficiency obtained and the great rapidity at which the motion can be worked. A comparison of the results obtained in actual practice of the modern method with the slow and inefficient luffing of a jib in the old style is particularly striking. It is, perhaps, unnecessary to explain that with a horizontal luffing motion the load is carried on a horizontal line and the jib is balanced in any position, so that the power absorbed is, therefore, for the purpose of overcoming frictional resistance, as the net work performed in the operation is nil. Fig. 11 shows comparative load diagrams of a luffing motor taken on a recording wattmeter for cranes of similar capacity, one being fitted with the old type of luffing gear and the other with a horizontal luffing motion and balanced jib. The area of the large diagram represents the power consumed with the old method, and the area of the inside dark diagram shows the power consumed with the horizontal luffing system. Although the power consumed with the horizontal luffing motion was only a fraction of that consumed in the case of the old method, it will be noticed that in addition to this merit the work was performed on the modern crane at about three times the speed at which it was performed by the old type of luffing gear. Owing to the development and success of the horizontal luffing crane, the motion of luffing is now often used instead of the more expensive and slower method of travelling. It is usual to fit limit switches to automatically arrest the jib at each end of its stroke, though with a horizontal luffing crane there is no actual moment tending to make the jib run out or in, as the system is in perfect balance at every point.

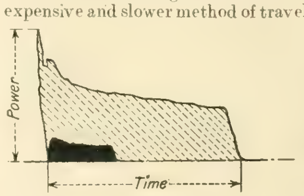


Fig. 11.

Cargo cranes are usually fitted with a travelling motion so that they can be adjusted to suit the holds of the vessels in which they are working. This motion is sometimes operated by hand and sometimes by power; the latter is, of course, a much more convenient method and can be controlled from the driver's cabin by the operation of one man, whereas with the hand travelling gear a number of men are necessary and the process is inevitably a slow one.

An important point in connection with cargo crane design is to arrange that the operator has an uninterrupted view of his load at all points, and a designer should not be afraid to give the cabin plenty of light area for this purpose.

A subject which has attracted a good deal of attention, particularly amongst crane users and makers during the last few years, is the investigation of the causes of wear of wire ropes. A considerable amount of thought has been given to the matter and a number of research committees have been appointed with the object of investigating the conditions affecting the wear of wire ropes. These committees have, I believe, collected a large amount of valuable data and designed apparatus for experimental purposes, and it is to be hoped that their reports will be published on the conclusion of hostilities.

A great deal has been said about the injurious effect of reverse bends in a rope system, and many people are of opinion that the effect of a reverse bend by deflecting the rope in an opposite direction introduces alternating stresses in the individual wires of the rope and causes them to break prematurely, and consequently to shorten the life of the rope. This doctrine should, however, be accepted with a certain amount of reserve, as it can be proved by practical demonstration that a rope in motion in its lateral direction is almost invariably rotating slowly round its own axis, so that it will be understood that with a comparatively short distance between the pulleys, what may appear to be a reverse bend on a drawing may be in reality a direct one in practice.

An undoubtedly sound idea to follow with the object of extending the life of the rope is to make the pulleys and barrels of large diameter, and without laying down any particular figures for guidance in this matter, although there are many available, the diameter of pulleys and barrels relative to the diameter of the rope which they coil, should, strictly speaking, vary according to the speed at which they work, and should also be greater in the case of pulleys than in the case of barrels.

Truck design of cargo cranes has undergone considerable modification during the last few years, and Fig. 3 shows a typical new design, which although more difficult to calculate gives better results in practice, being considerably less elastic than the old-fashioned trucks, and introducing a great saving in weight.

mounted with the following gear: A relay-type circuit-breaker connected in the mains, operating on two poles with overload and no-voltage release and loose handle, and provided with overload series coils in each of the separate motor circuits, but operating on the main circuit breaker. If desired, it may be arranged to be reset by a solenoid, so that it can itself be placed in a position where it cannot easily be tampered with. An ammeter and voltmeter may be added on the switchboard if desired. The limit switches on the derricking motion and the overwind switch on the hoisting motion should be of the self-resetting type, so that having operated any of these switches by overrunning on one side of the controller, they can be reset automatically by putting the controller handle to the other side.

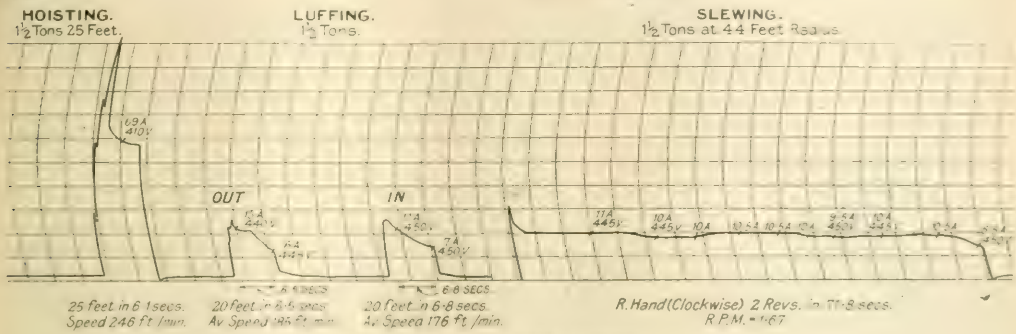


FIG. 12.—PERFORMANCE DIAGRAM.

By far the greater number of cranes in this country are at present revolved on live or fixed rollers, and supported on a turntable, but I venture to predict that the crane of the future will be developed along the lines of the post type as shown in Fig. 1. It would be possible to give many substantial reasons in support of this prediction, but time and space do not permit of it.

With regard to safety devices generally, it is a mistake to sacrifice simplicity by designing a crane which is bristling with complicated devices in an endeavour to make a gear which is absolutely fool proof. Even if such a condition can be obtained, it is a doubtful advantage, as the operator, believing that lack of attention on his part will not result in an accident, gets in the habit of allowing his intelligence to remain dormant, with disastrous results if one of the so-called safety devices fails to act. Generally speaking, within certain limits the fewer safety devices on a crane the greater the security, as it is better to train an operator to exercise his intelligence than to assume that he has no conscience and is incapable of any mental effort.

Having devoted so much space to the discussion of the mechanical gear of cargo cranes, I do not propose to give anything more than a brief description of the electrical gear of a typical crane. The motors in the case of direct current supply would be series wound, and the usual accepted condition for cranes is half hour rating for an 80° F. rise of temperature. The most satisfactory motor is the enclosed ventilated type, though there are a few users who prefer the totally enclosed type. The latter, however, has the disadvantage of being very large and difficult to accommodate, as well as more expensive, and there would appear to be no substantial reason for adopting this type under ordinary conditions when it is considered that crane cabins are usually of a very substantial nature in these days and thoroughly weatherproof.

The controllers are almost invariably of the drum type with mica insulation and magnetic blow-out. An important feature in a controller is to provide a definite notching device, so that the operator may feel when he is making proper contact on a controlling point. Where very large motors have to be controlled the ordinary drum type becomes difficult to operate, and in such cases contactors with master controllers make a very satisfactory system of control, and are particularly suitable for heavy service conditions such as are found in steel works. A very suitable form of switchboard is the enclosed type with front connections. The switchboard should be

The collector gear between the revolving superstructure and the fixed truck calls for no special comment, but it should be of substantial design and insulated by mica clamped on metal, and it is advisable to mount this gear in an accessible position on the crane. The main collector gear for the crane may be either by live wires underground or overhead, although the latter type is much less common than the former, and has certain [illegible]

FIG. 13.—A MODERN CRANE [illegible]

[illegible] on a cable drum when the crane travels. In the latter [illegible] plug boxes are provided on the [illegible] and [illegible] on the [illegible] for the other end. Fig. 12 shows a typical power curve for the hoisting, derricking and slewing motions of a crane [illegible] on a recording wattmeter, and Fig. 13 a photo of [illegible] modern cargo cranes in position.

Grabs.

Summary.—Among the auxiliary parts of crane equipment may be included the grab. In the present article details are given of mechanical construction, followed by a description of an electric grab and system of control.

FROM the many illustrations given elsewhere in this issue it is evident that grabs have played no mean part in the development of modern lifting machinery. Although it is not possible for us to deal exhaustively with these appliances it may, nevertheless, be of interest to describe a number of examples. The subject covers a wide field, but in the strictly limited space at our disposal brevity is essential.

In addition to being used for handling coal, ore and other bulk materials, grabs are frequently employed for excavating and dredging. They vary in capacity from a hundred, or so, cubic inches to several hundred cubic feet; or, in other words, when full will hold from a few pounds weight of material to as much as 15 or 20 tons.

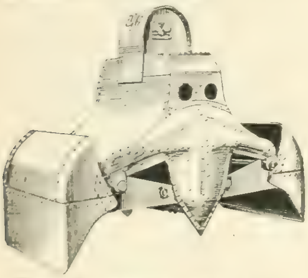


Fig. 1. Brownhoist Two-rope Coal Grab Bucket.

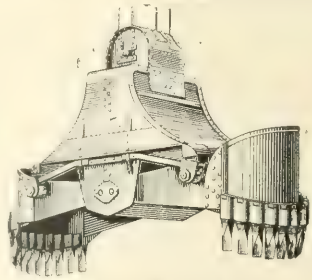


Fig. 2. Special Grab Bucket.

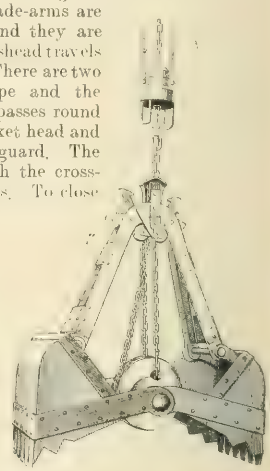


Fig. 3. Half-tine Grab for Close Sand Gravel or General Excavation Work.

Familiar examples are the clam-shell and orange-peel types. The first and most necessary qualification for a grab is that it fills itself in the material which it is handling. Another important point requiring attention is the spread of the spades when open; a large area covered gives to the grab a greater digging power than that of a grab of the same capacity but a shorter spread of the spades.

There are two general types of grabs, the two rope and the single rope. With the exception of the operating mechanism, both types are identical.

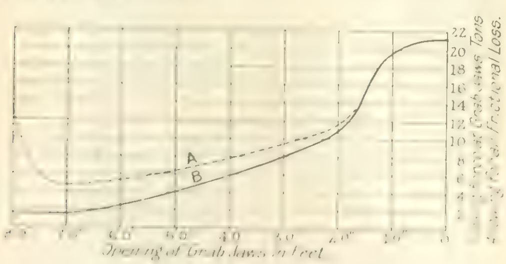


Fig. 4.

[illegible]

A two-rope clam-shell coal grab by the Brown Hoisting Co. is depicted in Fig. 1. The shape of the spades is such that when placed on the material ready for filling, the entire weight of the bucket rests upon the digging edges of the spades. The backs of the spades are placed at an angle when dumping, thus preventing anything in the spades or any lumps that may be encountered in the closing operation. When the grab is open, the backs of the spades stand vertical and as soon as the spades begin to close the backs become inclined in such a position that the material gathered assists or causes the grab to penetrate deeper into the material for its load.

The mechanism consists of a fixed set of three sheaves in the bucket head and a set in the cross-head. The latter has steel guide castings which fit over guide rails riveted on the inside of the shell. The spade-arms are pinned to the crosshead, and they are closed and opened as the crosshead travels up and down respectively. There are two ropes, namely, the shell rope and the closing rope. The shell rope passes round the middle sheave in the bucket head and is kept in place by a suitable guard. The closing rope is reeved through the cross-head and bucket-head blocks. To close the grab, the closing rope is drawn in; this lifts the crosshead and closes the spades, and the loaded grab is hoisted by means of this rope. When it is required to dump the load, the shell line is held fast while the closing line is paid out, thus allowing the cross head to drop and open the spades. In this manner the spades can be opened just as far as desired and at any point. The grab does not lower when the load is being dumped, unless it is desired to have it do so, thus enabling it to be used in limited

Fig. 5. Combined Grab Hopper Dredger supplied to Antwerp Harbour.

headroom, and it can be worked on bridge tramways, locomotive and overhead travelling cranes, man trolleys and derricks.

To guard against overloading in the case of the ore grab, the backs of the spades are left open so that any excess material may spill out before hoisting begins. On account of the extremely hard usage that such grabs receive when handling ore, limestone and other like materials the spades are made of manganese steel and all operating parts are well protected.

For extra heavy work, such as digging in large lump ore and limestone, the grab shown in Fig. 2 has been designed by the

Brown Hoisting Co. Its operation and general design are as already described, but the spades are rounded steel castings and are equipped with heavy manganese-steel teeth. So as to give greater digging power the crosshead is suspended on a 10 part rope.

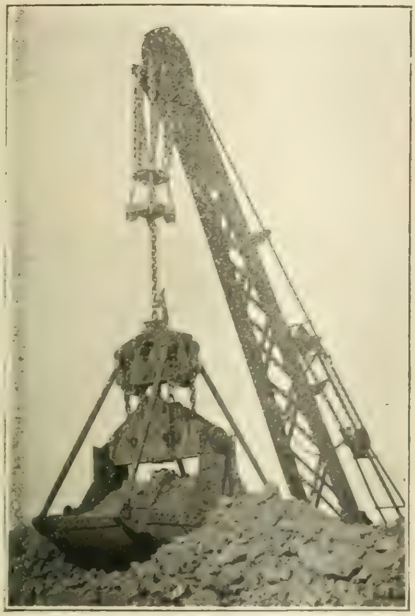
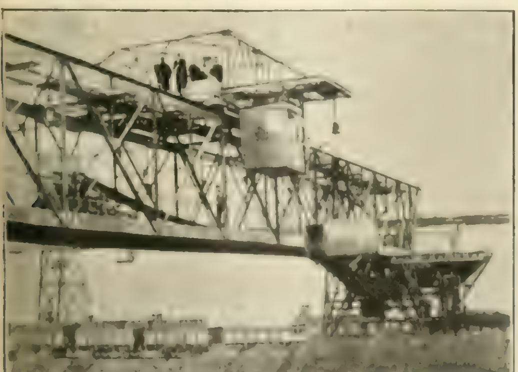


FIG. 6.—PRIESTMAN GRAB LOADING ROUGH ORE.

The single-rope whole-tine grab, illustrated in Fig. 3, manufactured by Messrs. Stothert & Pitt, is of simple design and contains few mechanical parts. It is made with 4 to 1 and 6 to 1 purchase, and the whole-tine construction is used for compact gravel, clay, rock and like materials. The efficiency is high owing to the simplicity of operation and the [illegible]



[illegible]

[illegible]

is avoided, as the closing [illegible] done throughout the stroke, commencing by gathering the material, which gradually increases in weight, and finally forcing it into the bucket and crushing through any obstacles between the jaws.

Owing to the few moving parts the spades open and close smartly, and friction, with consequent wear, is minimised. From the illustration, Fig. 3, it will be seen that the grab has no special crosshead, the whole of the mechanism being contained within the [illegible] hinged A-frame, thus avoiding all parallel motion and cross-binding. The closing barrel does not make a complete revolution and, in the act of closing, the barrel revolves quite clear of the contents of the grab. The eccentricity of the barrel is also useful [illegible] Another important feature of the design is that the centre of gravity is very low, the heaviest part being the [illegible]

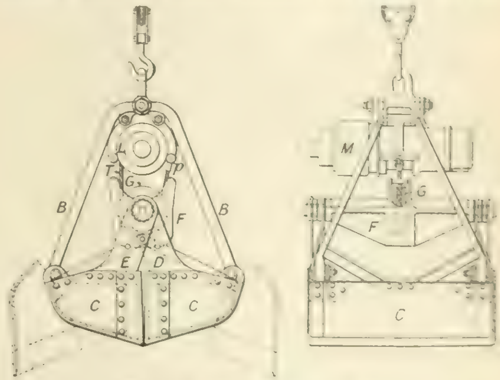
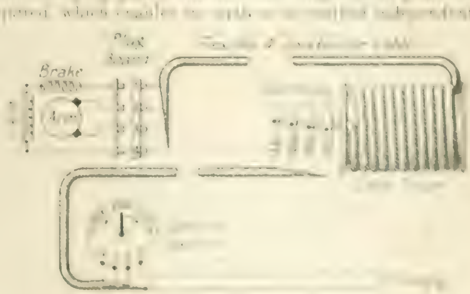


FIG. 3.—[illegible]

tendency to overturn, even when [illegible] The space occupied by the grab is very small, and as no ball is necessary on the chain the grab can be worked close up to the jib-head of the crane.

These grabs, which are [illegible] are designed to work with single [illegible] and are adapted to all conditions of working and every kind of material. [illegible]



[illegible]

[illegible]

[illegible]

the war. It is not within the scope of this article to set out all the advantages of the grab over other types of dredging apparatus; nevertheless the grab system enables materials to be dealt with which no other dredger can handle satisfactorily, and in confined and crowded waterways where it is important to conserve the water, the grab is particularly advantageous.

Fig. 7 represents part of a large coal-handling installation recently put to work in France, where grabs are probably more extensively employed than in any other country, especially for discharging coal. We understand that no less than 82 grabs have been supplied to one port by Messrs. Priestman.

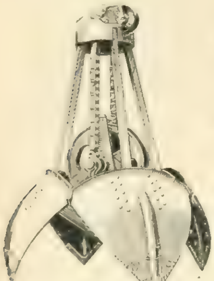


FIG. 10.—HAYWARD "ORANGE PEEL" BUCKET.

The motor-operated single-rope clam-shell bucket shown in Fig. 8 is made by the Hayward Co., of New York, and has a wide sphere of usefulness wherever bulk material is to be handled. An important advantage is that it may be operated by any crane of capacity sufficient to lift the loaded bucket.

The two sections of the bucket are opened and closed by a winding-rope wound on a drum actuated through a friction-clutch and gearing from an electric motor carried in the grab frame, and controlled from a distant point. As will be seen from Fig. 8 the bucket sections C C are pivoted to links B, and are connected by arms D, E to a weighted member F carrying a sheave G. The opening and closing rope T is attached to a fixed point p and passes round the sheave G to a drum mounted in a frame L which carries the motor and gearing. The motor M actuates a pinion which transmits motion to a part of the drum through sun-and-planet gears. A simple form of controller is used for opening and closing the grab, and when the bucket is fitted to an electric crane the controller is usually housed in the operator's cage, but it may be located in any convenient position.

Where the service is such as to require a long conductor cable the latter may be kept off the ground and clear of obstructions by means of a reel, Fig. 9, which automatically pays out and coils up the cable as required.

The Hayward orange-peel two-rope grab is made in a variety of sizes and is adapted to excavation work of all kinds, the grab illustrated in Fig. 10 being known as the "extra heavy standard" and recommended for all classes of work requiring a

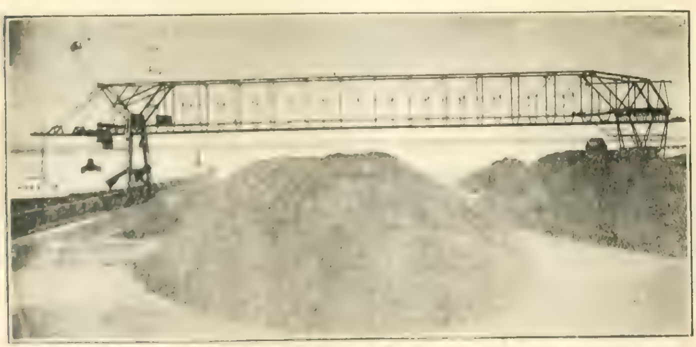


FIG. 11.—HEYL & PATTERSON 12-TON MAN TROLLEY BRIDGE, HAVING 603 FT. SPAN AND OVER-ALL LENGTH OF 715 FT., FOR UNLOADING, STORING AND RECLAIMING BITUMINOUS COAL.

variety of heavy construction. As examples of such work may be mentioned canal digging, digging out cribbing, pulling piles and stumps, cylinder sinking, foundation work and dredging.

The digging or closing mechanism in these buckets consists of a power wheel and side chain device acting as a lever and actuated by the closing line which passes round the power wheel. The upper centre casting is provided with an oscillating head, carrying a manganese-steel sheave, which allows the grab to hang central under all conditions. Straight arms are riveted to the blades, which are corrugated at the back to give additional stiffness and are fitted at their points with renewable steel shoes. The frame, in which the power wheel runs, is connected to the lower centre and is provided with rope guards to prevent the closing line leaving the wheel. Flat link side chains attached to the power wheel cams connect the upper and lower centre castings, and the upper centre casting is joined to the outer end of the blades by means of four connecting-rods, as shown in the illustration.

In the multi-power grabs of this type the mechanism is so arranged, by using a two-part side chain, that nearly 60 per cent. more penetrating power is obtained. If so desired, the

FIG. 12.—MAN TROLLEY EQUIPPED WITH 12-TON CLAM USED ON THE BRIDGE SHOWN IN FIG. 11. THE CLAM WHEN OPEN HAS A SPREAD CROSSWISE OF THE VESSEL OF OVER 22 FT.

grabs may be rope-reeved and arranged to close by from 3 to 7 parts of line depending on the conditions under which the grab is to be operated. Dwarf orange-peel grabs are available for sinking pipes and wells from 12 inches diameter, for digging test holes and mould pits in foundries and for other work where it is impossible to use a large grab. One of these dwarf grabs is said to have sunk a 14-inch pipe to a depth of 80 ft.

During the past 15 years over 100 patents have been granted for improvements in grabs. From this it will be seen that the ground cannot be covered in a short article, nor can the whole of the principal improvements be noted. In the foregoing, by confining our attention to three or four typical examples, we have been able to indicate the performance to be expected and to record the present day practice of a few of the many firms who have made a special study of the handling of materials by means of grabs.

We are indebted to Mr. G. H. Hutchinson, chief engineer of the North Western Fuel Co. (U.S.A.), for the two interesting photographs which we reproduce in Figs. 11 and 12. In an article by Mr. Hutchinson, which appears on another page of this issue, an account will be found of the methods adopted for handling coal and iron ore in the United States. Fig. 11 shows the largest coal handling bridge thus far constructed, which was installed in 1913 on the North Western Fuel Co.'s Railway Dock, Superior, Wisconsin. By means of this bridge coal can be stored to a height of [illegible] ft. The grab is noticeable at the left hand end, and is shown in detail in Fig. 12 from which the large proportions are seen.

Electrical Machinery in Coke-Oven Works.

By ALWYNE MEADE, A.M.INST.C.E.

Summary.—Electrical plant is now used extensively in operating coke-oven works and gas works. Of this plant it may be said that charging machinery is the most interesting. In the case of coke ovens this is of two types, being used for (1) overhead charging, in which case unstamped coal is used, or (2) side charging, for which stamped coal is necessary. In gasworks the charge per retort is much less, and consequently different methods may be adopted. An interesting example is the de Brouwer projector.

OUT of a normal annual output of coal in the United Kingdom of approximately 280,000,000 tons nearly 16,000,000 tons are dealt with for the production of metallurgical coke. For many years the coal so employed was treated in the old-fashioned beehive ovens, which, while yielding a coke of excellent quality for many purposes, were extravagant to the extreme in that the whole of the valuable by-products of the coal were lost. The beehive oven is still to be found in this country, but its place is gradually being taken by the by-product system which, though extravagant from the point of view of capital expenditure, possesses the merit of recovering in saleable form a large proportion of the volatile constituents of the coal. It is not possible to give any exact figures as to the quantity of coal now treated by the modern by-product process, but a close estimate places the amount at present dealt with in beehive ovens as rather less than 5,000,000 tons, thus it may be said that well over 10,000,000 tons per annum are now utilised in recovery ovens.

Electrically-operated machinery is a feature of the up-to-date coke-oven installation, for there is no cheaper form of

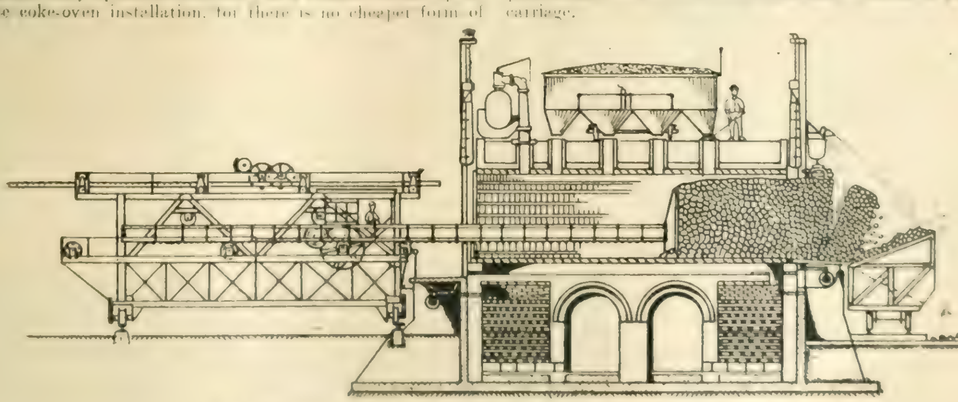


Fig. 1.—Diagram of Semet-Solvay Ovens, showing Coke Ram in Action.

power than gas-generated electricity, and this is particularly the case when coke-oven gas is available, owing to the gas being a subsidiary product for which in many cases there is very little demand beyond that portion required for heating the ovens themselves. Accordingly it is usual to find on these establishments all manner of electrical conveying and elevating machinery, electric locomotives and electric coal charging and coke discharging apparatus.

To those not directly connected with recovery oven practice it is the [illegible] machinery employed for filling the immense chambers with coal and for pushing out the coke at the end of the period of carbonisation which usually arouses the chief interest, for this type of apparatus is to be found at coke works alone. It should be explained at the outset that there are two distinct methods of dealing with coal for the production of foundry coke. With the average Durham coal containing 25 per cent. of volatile matter, it is customary to arrange for charging at three or four points through the roof of the oven, but as coal so charged would lie in an uneven layer, an auxiliary machine consisting of a long bar carrying a rake-head is employed for levelling the charge. Other coals, such as certain Yorkshire varieties, which contain an excessive proportion of volatile matter, require different treatment, however, for if merely charged into the oven as in the more common manner the resulting coke would be highly porous and soft, bearing a close resemblance to ordinary gas works coke. For this reason it is essential to subject the coal before use to the process known as "stamping," whereby the coal is firstly charged into a rectangular trough roughly of the same shape as the ovens, but of rather smaller dimensions. The "stamping" machine then travels backwards and forwards above the trough and compresses the coal into one immense cake which is ultimately carried bodily into the oven.

So far as charging is concerned, then, the system calls for the following apparatus :—

(*a*) *Overhead Charging* (Unstamped coal).—A power-driven hopper machine travelling on top of the ovens, filling by gravity. In conjunction with this is required (1) a ram levelling machine, travelling on a platform in front of the ovens, and (2) a coke pusher for effecting discharge. The pusher and leveller are almost invariably erected on the same carriage.

(*b*) *Side Charging* (Stamped coal).—A [illegible] machine travelling alongside the ovens, fitted with a compression trough and stamper. The machine is so arranged that the cake of coke, resting on the bottom plate, may be carried into the oven. No levelling machine is required, but as before a coke pusher for discharging must be provided.

The majority of the present-day ovens are of such capacity as to take a charge of coal varying from 8 to 12 tons, the coke yield from each oven falling between 6 and 9 tons. As a point of interest it may be mentioned that [illegible] the expenditure on a battery of coke ovens at [illegible] amounted, approximately, to £300 per ton of coal treated per diem.

Moving Machines.

The machines, charging and discharging apparatus employed are usually operated on similar principles, and differences in design are chiefly a matter of detail. Prior to the war nearly every machine to be found in this country was of German manufacture and design, but it is satisfactory to know that several British firms have [illegible]

It is interesting to note that one of the chief German establishments where coke oven machinery (which in pre-war days found its way into this country) is built is the firm of Méguin, of Dillingen on the Saar, a town which has frequently been attacked by the Allied air services. Without making special reference, for the moment, to the apparatus of specific firms, it may be as well to give a general description which may be

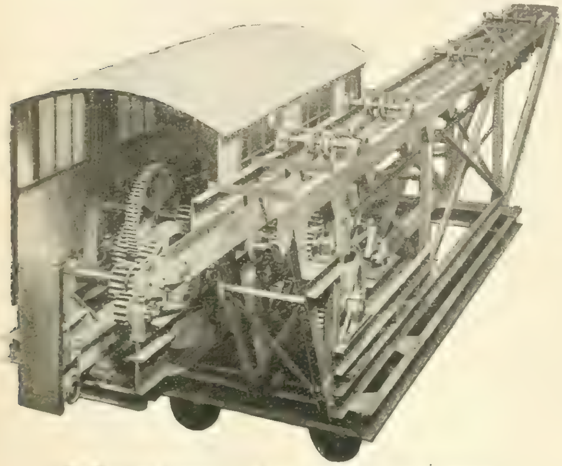


Fig. 2.—The Coppée Ramming and Levelling Machine.

said to cover most forms of coke-oven machinery as found at present. As regards the combined pushing and levelling machines the main frame is built up from steel sections, and upon this frame are mounted the mechanical portions, with the driver's cabin and motor house. The machine travels on track rails mounted in front of, and parallel with, the bench of coke ovens, the carriage being mounted on chilled cast-steel wheels keyed to forged-steel shafts. The coke-pushing ram is constructed from built up steel girders which are fitted with a cast-steel pusher head of the same section as the oven, but of rather smaller dimensions, the head being fitted with a guide roller on the bottom, and with two other rollers, one on each side. On the upper surface of the girder is firmly fixed a cast-steel rack in which the cast-steel driving pinion gears. The levelling rake is supported alongside the pushing ram and is usually fitted with automatic reversing mechanism. In many machines a single motor is sufficient to provide for the whole of the different motions required, namely, pushing, levelling and travelling, while the driver controls each of these movements from his place by means of a lever arrangement operating the various couplings. A strong screw brake is usually provided which enables the driver to stop the machine immediately in front of the oven to be dealt with. The weight of a machine of this kind is in the neighbourhood of 24 tons, while the power required is roughly [illegible]. In [illegible] British-made machines separate motors are provided for operating the pusher and for traversing the machine, and the pusher has a slow forward and a fast backward motion. Both in the pushing and charging machines it [illegible] and [illegible] the power required is comparatively high, amounting to [illegible] h.p. or less.

A diagram illustrating a typical coke discharging and levelling machine is shown in Fig. 1, which depicts a vertical cross section through one of the well-known Semet-Solvay coke ovens. These ovens are of the large size, being 36 ft. long, 12 ft. high and 21 in. wide, with a 2 in. taper, each holding a charge of coal amounting to 16 tons. The period of which distillation takes place is from 17 to 18 hours, according to the coal used and the grade of coke required. Fig. 2 shows a front view of the complete ramming and levelling machine as manufactured by Messrs. Coppée of London. The levelling beam may be seen at the top of the exposed portion, while the head of the coke pusher and a portion of the pusher beam is seen in the bottom left hand corner. This machine is usually fitted with a single motor of 50 h.p., which performs the whole of the operations. The total weight of the machine is roughly 50 tons, while its cost to-day is about £3,500 inclusive of all electrical equipment.

Chargers and Stampers.

A typical charging car as now built in this country is shown in Fig. 3. This car is designed to charge ovens having four charging doors spaced along the top of the oven, and has, therefore, four distinct hoppers. To ensure that the coal will run easily during charging the hoppers of the machine are made with rounded corners, and, to prevent any moist coal (delivered from the main storage hoppers) from compressing into a more or less solid mass in the car hoppers, specially designed plates are arranged across the top so as to break the fall of the coal. The outlet doors, or mouth pieces, are each fitted with a duplex type of damper, and these are operated from the driver's platform by means of hand levers. The motor is of the totally enclosed reversible type of 20 h.p., the drive being through spur gearing, the pinion on the motor shaft and the wheel into which it gears being of the machine-cut Citroen type. The current is taken by tramway type collectors from overhead wires, while the controller, starting gear, and foot brake are all arranged in convenient positions in the driver's cabin. The fully loaded capacity of the machine is 12 tons of coal, while its total weight when loaded is about 30 tons. The travelling speed of the car is 3 miles per hour.

A modern machine for charging ovens from the side is seen

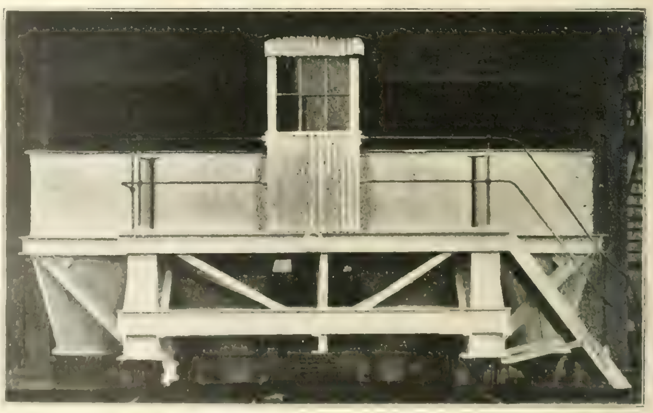


Fig. 3.—The Coppée Charging Car.

in Fig. 4. In this instance no leveller is necessary, so that charger and pusher are carried on the same framework, as may be seen. The coal is received from the main storage hopper in a special trough (shown in the left hand corner of the illustration) in which it is submitted to the process of stamping. Once the coal has been compressed into the form of a cake the sides of the coal trough are drawn slightly outwards from their original position, thus freeing the cake of coal which

then rests on the bottom plate of the trough. The oven door is then opened and the bottom plate is propelled forward into the oven, carrying the charge of coal with it. Once the coal is in position the bottom plate is withdrawn, leaving the compressed charge behind in the oven. The stamping machine, as used for compressing the coal, is clearly shown in Fig. 5. The machine during its operation travels to and fro on an overhead runway placed directly above the compression box. The reciprocating [illegible]

bourhood of £2,770. The stamping machine is not included in this price, and would be responsible for another £950. The last named machine is separately driven by a 10 H.P. motor.

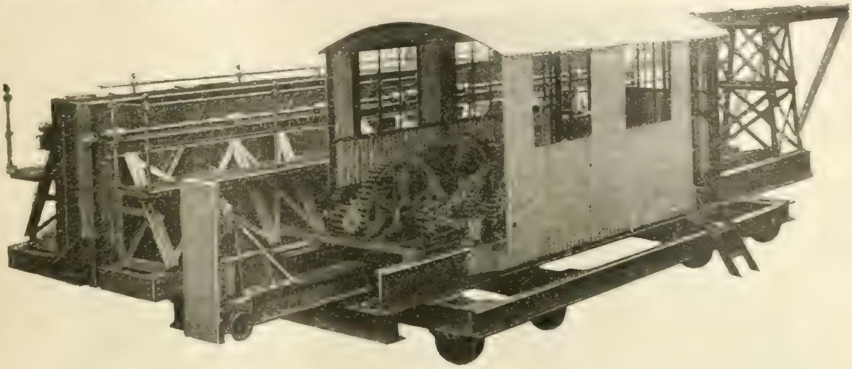


Fig. 4.—The Coppée Charger for Stamped Coal.

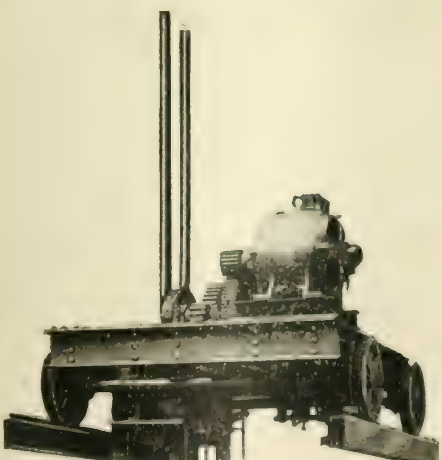


Fig. 5.—The Coppée Stamping Machine.

[illegible]

Gasworks Chargers.

The machines employed for charging and discharging purposes on gasworks differ essentially from those found on coke-oven works in that, in the case of gasworks, the individual charge of coal is very much smaller than that of the oven, amounting in general to only some 11 cwts. to 13 cwts. per retort of 20 ft. length. Moreover, while coke-oven machinery depends wholly on electrical energy many forms of power are to be found in use in gasworks, a number of existing machines being operated by hydraulic power and compressed air. Although a certain amount of rivalry naturally, and for the good of the public fortunately, exists between purveyors of gas and electricity, the modern gas engineer is in no sense so narrow-minded as to exclude electrical plant from his works if it is found to be the most effective form available. The consequence is that most of the later forms of stoking machinery are operated electrically. The current, however, is invariably generated on the works by means of gas engines, and proves particularly economical in that the gas used is obtained at cost into holder, [illegible] heavy charges [illegible] days it was possible [illegible] into holder at so low a rate as [illegible] and—in exceptional cases—even less.

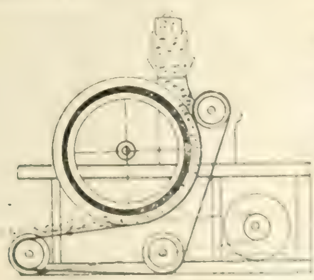


Fig. 6.—Diagram Showing Principle of [illegible] De Brouwer Gasworks Charger.

Of the more [illegible] charging machinery [illegible] given to the [illegible] apparatus wherewith the coal is thrown into the retort by [illegible] a high initial velocity. The [illegible] operating on this principle is the [illegible] of M. De Brouwer, formerly gas engineer at [illegible]. The [illegible] the act of charging [illegible] by Fig. 7. The principle of operation will be readily understood by reference to the line diagram, Fig. 6. [illegible] general pulley. [illegible] of the pulley and [illegible]

speed as the belt. The band is driven by ordinary belt drive on the front band pulley from a shunt wound variable speed electric motor of 4 B.H.P. to 6 B.H.P., having a speed variation of 750 revs. per min. to 1,500 revs. per min. A telescopic coal shoot leads from an overhead measuring chamber to the groove of the large pulley. The operation of charging is as follows :— After starting up the motor, the operator moves the handle of his speed regulating rheostat into the position necessary for giving the projector belt the desired speed. This speed varies according to the length of the retort to be charged, the class and pyhsical condition of the coal used, and the thickness of the charge desired, and must be found by trial. With ordinary broken coal and charges of about 9 cwt., the belt speed should be about 2,300 ft. per min., but for perfectly full charges a greater speed will be necessary. The centrifugal force exerted on the coal as the belt passes round the circumference of the grooved drum keeps the coal in contact with the belt, so that the velocity of the coal becomes the same as the velocity of the belt. As the coal reaches the front pulley the belt is suddenly deflected round the pulley, and the momentum keeps the coal travelling forward into the retort in a continuous stream. The distance through which the coal travels is gradually decreased as the operation of charging proceeds, this being effected by a gradual reduction in the speed of the band. The whole operation of charging takes from 20 to 30 seconds according to the amount of coal put into the retort. The following are the more interesting points connected with the de Brouwer machine :—

Large pulley : Diameter, 1 m.
.. .. Width on face, 15 in.
.. .. Width of groove, 8 in.
.. .. Depth of groove, $3\frac{3}{4}$ in.
.. .. Average speed, 220 revs. per min.
Power required, 10 to 15 amperes at 220 volts.

It may be noted that the average life of a de Brouwer belt is from 12,000 to 20,000 tons of coal. The belt costs about £15 to replace, and represents an expenditure of about 0·225d per ton of coal. The cost of the machine, complete with wiring, is about £800 (pre-war price), depending upon the number of tiers of retorts and the method of coal feeding adopted. As regards the saving of labour effected it may be mentioned that with the old-fashioned method of charging and discharging retorts entirely by hand the cost involved amounted to nearly 3s. per ton of coal handled, whereas with electrical projectors and " pushers " the working cost may be reduced to 15d. per ton of coal.

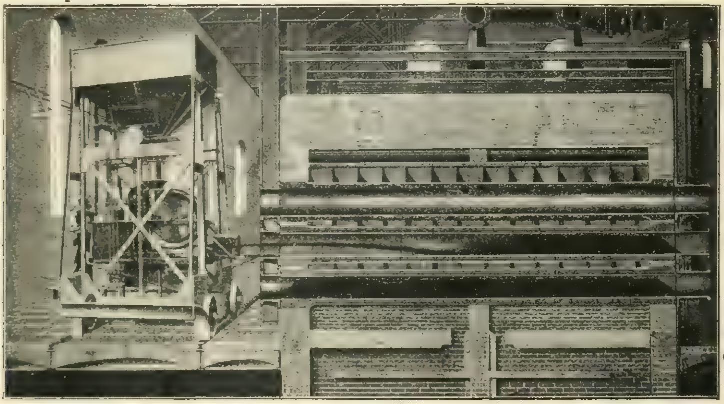


Fig. 6.—De Brouwer Machine in the act of Charging a Retort

Electrically operated discharging pushers as employed on gasworks need no special attention in that they resemble very closely those already described for use on coke oven establishments. The gasworks pushers are, of course, of very much smaller dimensions than the coke oven types, and the pusher ram, instead of being continuous, is of telescopic design.

PULVERISED FUEL FOR POWER PLANTS.

In the "General Electric Review" for October an interesting account is given by H. R. Collins and J. Harrington of the use of pulverised coal for eight 191 h.p. boilers at Parsons, Kansas. [illegible] were equipped for using natural gas or oil for fuel. Attempts were made to use some of the fuel in the district but owing to the high ash and moisture content (in some cases containing as much as 20 per cent. ash and in others 30 per cent. moisture) it was determined to investigate the feasibility of using these fuels in a pulverised form.

The electrically operated pulverising and drying equipment is located at one end of the boiler house, the coal passing through a crusher and then dropping on to a 20 in. inclined belt conveyor which discharges direct into a set of Lehigh [illegible] rolls. A magnetic separator removes the [illegible] pieces of iron or steel in the fuel. The dryer evaporates moisture from coal containing 10 per cent. moisture to 1 per cent. at the rate of 7 tons per hour. (Successful treatment is necessary in the case of lignite which contains 30 to 40 per cent. moisture.) Ultimately 95 per cent. of the material will pass through a 100-mesh screen at the rate of 4 tons per hour. The capacity of the entire pulverising plant is 180 tons in 24 hours and the power house at present requires about 96 tons in 24 hours.

Each pair of boilers is provided with a blower driven by a 10-H.P. constant speed direct-current motor. The action of the high velocity jet from the blast pipe induces a large volume of air through the induction tube, and the fuel is thoroughly mixed with this air-current, burning with a flame which practically fills the combustion chamber.

Tests made with the local fuels have met with entire success, giving an effective distribution of heat throughout the heating surface of the boiler with low stack temperatures. No deposit of ash settles anywhere in the boiler that cannot be readily dislodged with an ordinary air blast. With Texas lignite an equivalent evaporation of 7·26 lb. of steam was obtained per pound of coal fired, an equivalent evaporation of 8·81 lb. being obtained per lb. of combustible. The coal as fired had a heating value of 11,250 B.Th.U. The efficiency of the boiler was 67·3 per cent. Including the cost of pulverising, which is about 35 cents per ton, the cost of coal delivered to the bins was $1.79. The cost of evaporating 1,000 lb. of water by this test was 11·6 cents.

Charging Machines.

By FRED. G. SMITH.

Summary.—Reference is made particularly to the use of charging machines in steel works. Such machines lead to a large saving in labour, as shown by typical figures of cost. Owing to the number of independent movements that are required, the wiring is somewhat complicated, and requires careful study to avoid annoying breakdowns. Also, owing to severe conditions of service, the designs must be ample. Illustrations are given of up-to-date machines.

In writing of charging machines one cannot say, as of most machinery, that electricity has superseded steam, because the first open hearth charging machine, invented by Mr. S. T. Wellman, was electrically operated, and, with the exception of one or two isolated cases, all machines have been and are electrically driven.

The title covers a vast range of machines for many purposes, but in this article it is restricted to steelworks plant.

There are two main conditions which must be fulfilled by charging machines—namely, speed and reliability.

Speed can always be obtained by using a large enough motor and electric brake, the first to give high acceleration, and the second to give quick retardation. Given the above, it is for the mechanical engineer to design a machine that will withstand the heavy stresses without using so much weight that the object of the large motor is neutralised. That this has been successfully done will be obvious from the following short description of a few typical examples of the manufacture of a leading firm.

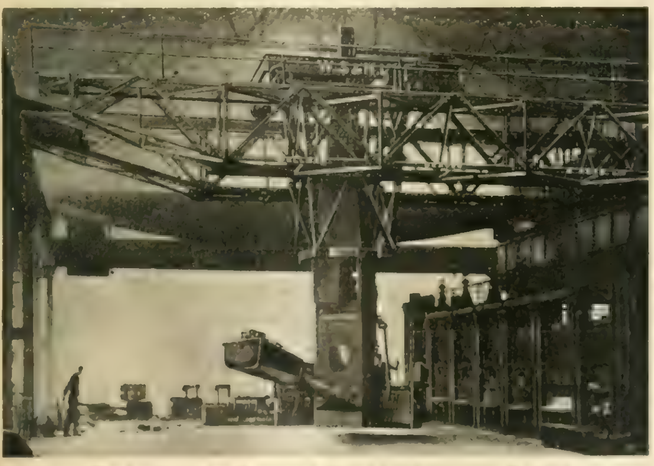


Fig. 1.—Overhead Revolving Open-Hearth Charging Machine.

Before describing the machines in detail it would, perhaps, be as well to point out the labour-saving value of the apparatus. For this purpose only one type of machine will be taken as an example, the machine for charging open hearth steel furnaces. Such a machine costs, say, £2,000, plus the necessary boxes and bogies, cradles, &c., at a cost of £1,000, or a total cost of £3,000. This plant will charge four 40-ton furnaces and displace two men per shift per furnace, or a total of 16 men at an average wage of say 60s. per week, or £2,500 per annum. The cost of running will be as follows:—

Depreciation and interest on capital at 10 per cent.	£300
Wages of two drivers	300
Oil, waste, current, &c.	100
Cost of running	£700

This gives a saving of £1,800 per annum, and in addition an increased output of steel is obtained. With the introduction of the eight-hour shift the figure is increased, 24 men being displaced. Similar results can be obtained with machines for handling ingots, blooms, &c.

Fig. 1 shows an overhead revolving open hearth charging machine of the most improved type, and the design most frequently installed. This machine runs on an overhead runway, and has the following five separate motions:—

Longitudinal travelling of the whole machine along the shop.
Cross-travelling of the trolly on the bridge.
Slewing of the central mast through a complete circle.
Rocking or angling of the charging arm.
Rotating of the arm for discharging the box of material at the end.

Five separate motors and control gear are provided, the latter being conveniently arranged in the driver's cab, and coupled to the motors through flexible cable, sliding collectors and rotating contact rings.

Fig. 2 is a typical wiring diagram, carried out with drum controllers. The arrangement of the wiring and design of the details carrying current between the moving parts requires careful study to avoid annoying breakdowns.

It must be borne in mind that electrical machinery in steel works is subject to very rough usage in a badly lighted shop, full of chemical fumes and steel dust, &c.; it is expected to work day and night continuously with only a short week-end stop for adjustment, and even that is sometimes omitted. A person with any respect for the domestic mangle would not subject it to such treatment.

Another point that should be mentioned is that machines are seldom worked at their designed loads. The idea in steel works seems to be to pile on the load until something goes, and if for any reason it cannot be increased to breaking point, and the machine works merrily on, then why worry about it. It gets no attention, and finally goes down somewhere. Not all steel works are as bad as this, but with the best of attention the conditions under which the machinery works are very bad.

That English designers have produced machines to withstand such treatment is borne out by the fact that a machine similar to that shown in Fig. 1 has been working day and night for five years charging four furnaces and a mixer, producing over 2,000 tons of finished steel per week without any serious stop.

Improvements are continually being made, both electrical and mechanical, as the result of experience. Perhaps the most important advance recently is the development of the contactor control fitted with current limit. This electrical device has eliminated a lot of troubles which were previously placed to the mechanical engineer, and doubtless other electrical improvements will be made with like results.

The high speed at which charging machines are driven makes it necessary for the operator to be very smart, often at the expense of the machine. An operator will find that he can work faster by running full speed to the end of the motion and stalling the motor by reversing the controller. The strains set up in the machine, and the high voltage induced in the electrical parts are severe, and particularly [illegible] that fashion. By installing current limiting contactor gear this trouble is overcome, because, however fast the operator's controller may be thrown over, the contactors can only cut out the resistance step by step at a predetermined load. One may argue that it is unnecessary to drive at such a speed

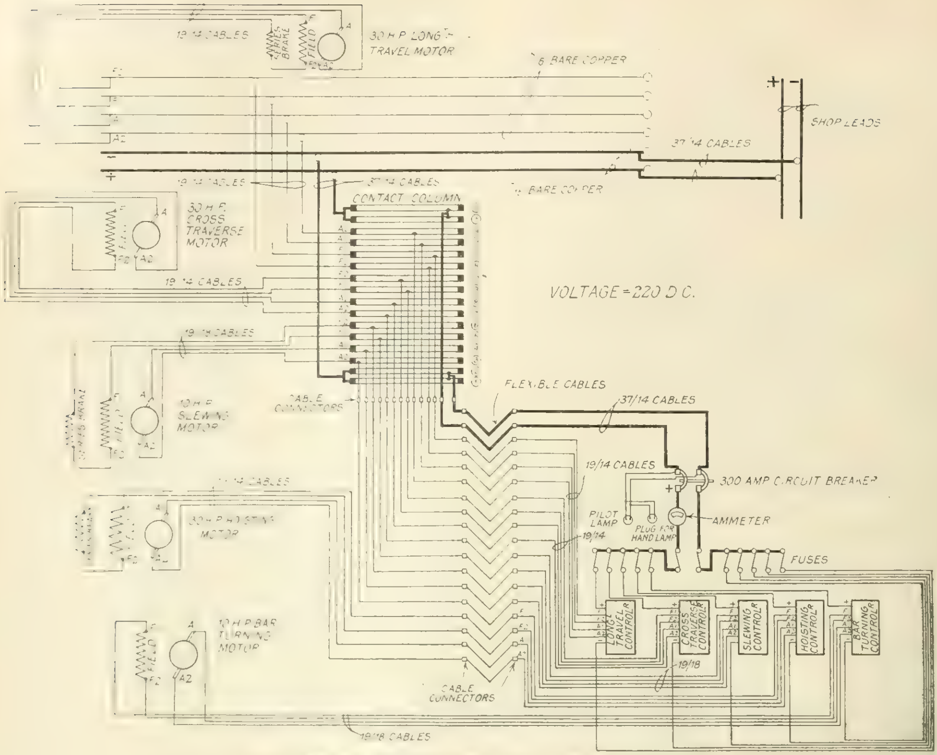
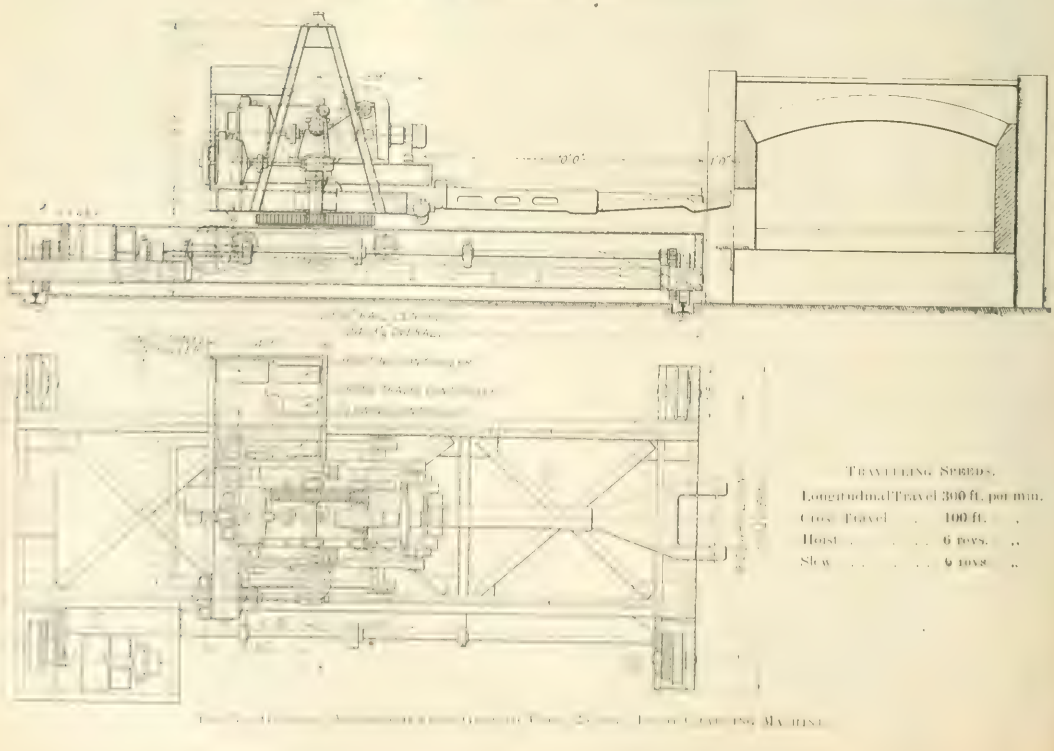


Fig. 2.—Typical Wiring Diagram of a Charging Machine.



Travelling Speeds.

Longitudinal Travel	300 ft. per min.
Cross Travel .	100 ft. "
Hoist	6 revs. "
Slew	6 revs. "

[illegible] Charging Machine.

contactor control would be too slow, but this view has been demonstrated to be false, several machines having been fitted recently with contactor control which have shown quicker working and more freedom from breakdowns.

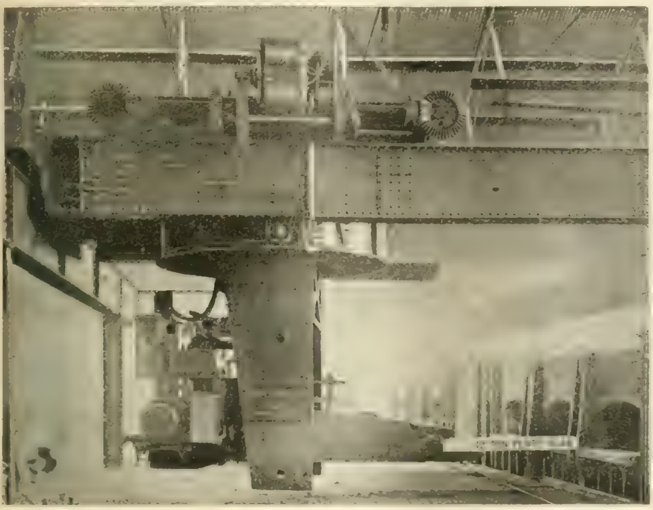


Fig. 4.—Charging Machine for Handling Large Plate Slabs.

A machine as shown in Fig. 4 will consistently charge a box into the furnace every 60 to 70 seconds, taking the box from the back of the stage, making a half circle to charge, and return the box to the back—an operation needing, when the driver is expert and conditions most favourable, 12 distinct movements in the control levers and two on the locking lever of the box. The number of movements frequently runs up to 18 with adjustments that are required. The control gear must, therefore, be of the best, and rated much higher than the standard commercial article.

Enough has, perhaps, been said as to conditions and difficulties to be overcome in designing, and a description of some further types may be of interest.

Fig. 3 shows a ground type charging machine designed to handle 15 cwt. ingots for rolling into thin bars. This type often has to run between two rows of furnaces only 20 ft. apart, where the temperature of the atmosphere is considerably over 100 deg., and the parts of the machine nearest to the furnace are too hot to touch. The machine generally has four motions as described for the open hearth machine, but has a fixed peel for lifting the ingot.

Fig. 4 shows a machine designed to handle large plate slabs up to 12 tons weight, and is interesting owing to the method of gripping the plate. It will be seen that the grip is provided with a top and bottom jaw similar to a pair of pliers. The bottom jaw is not fixed, but is free to move about a pin, the back part of the jaw being coupled to the upper jaw through links and inclined planes. The jaws are opened and closed with a 12 h.p. motor, which adjusts the grip to the slab to be lifted. Upon lifting, the grip on the load exerts a pressure on the bottom jaw which is transmitted through the links and inclined planes to the upper jaw, causing it to grip the slab securely. The pressure on the slab is, therefore, always proportional to the load lifted, and does not depend on the [illegible] of the [illegible]. [illegible]

The above machines handle the ingots or slabs [illegible] horizontal [illegible] furnaces and the rolling mill.

Another type of machine is shown in Fig. 5 for handling from vertical furnaces called soaking pits, [illegible] originally intended that they should be [illegible] pits in the ground, [illegible]

the initial heat in the centre of the ingot to soak outwards to an equal rolling temperature throughout the mass. It has been found in practice that some amount of firing is required to allow for radiation, and, in addition, it is necessary for various reasons to charge some cold ingots to the pits. This machine is very fast working, hoisting at 60 ft. per minute, and travelling at 450 ft. per minute, both motors being 56 H.P. and fitted with contactor control.

Many other machines might be described, such as telphers, cranes and pushers, which are adapted to charging various materials in steel works. The most interesting, from an electrical point of view, are the ladle cranes, handling anything from 20 tons to 100 tons of molten steel. To hold the load is quite a simple proposition, but to lower the load under proper control without any jerks is not so simple. Several electrical methods are now used which all have the same basic principle of using the motor as a generator and only differing in the method of connecting up, such as the regenerative, rheostatic and potentiometer methods of control. Although when well designed these systems appear to be perfect, the writer has known cases when the motor field has refused to build up and the load has dropped. Investigation has failed to locate the fault, and the next lift has been all right. It is, therefore, desirable when handling molten metal to have a large mechanical

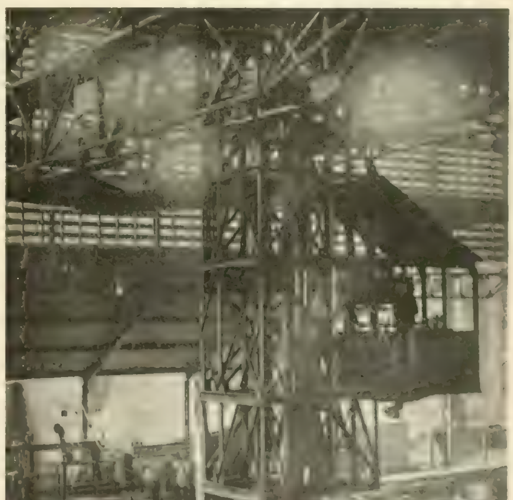


Fig. 5.—Machine for Charging [illegible] Soaking Pits.

[illegible]

[illegible] charging machinery and the [illegible]

Lifting Magnets.

Summary.—The first part of the present article deals with the operating costs of lifting magnets worked under widely varying conditions, after which the important point of rating is briefly considered. Descriptions are given of a number of lifting magnets, followed by details of method of control.

THE lifting magnet ranks high as a modern appliance for the economical handling of steel and iron, and the more awkward the load the greater is the economy. Thus, in a certain works the installation of a scrap handling magnet crane enabled the owners to dispense with the services of 13 labourers. At 25s. per week per man this represents £845 per annum, and after deducting working expenses and other charges a sum remains which is sufficiently large to pay for the equipment in a few years.

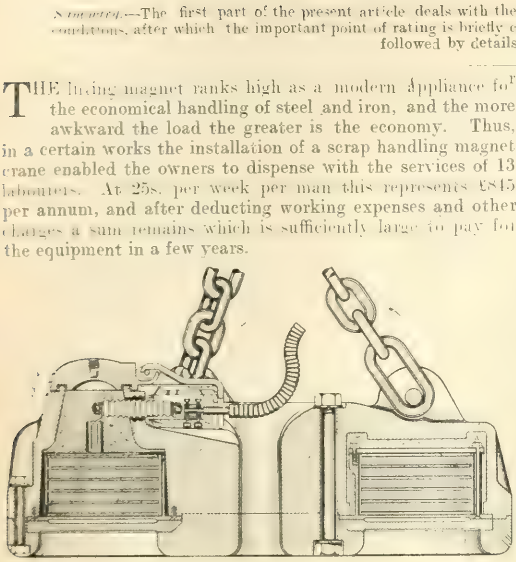


Fig. 1. Section of Lifting Magnet by Marryat and Place.

Operating Costs. The following data give the operating costs of a 52 in. magnet worked under adverse conditions. The travel of the crane varied from nothing to 25 ft., the traverse was 15 ft. and the lift about 15 ft. Material was unloaded from railway trucks into charging boxes and was trimmed by two stockers, except in the case of pig iron, when only one stocker was required.

Handling Light Angles, Beams and Rail Scrap about 3 ft. to 5 ft. long.

Total weight handled	66,700 lb.
Weight per lift	1,058 lb.
Lifts per hour	122
Weight per hour	54·8 tons

Handling 6 in. by 6 in. by 3 in. Blooming mill Crop Ends, Snow-covered and Frozen.

Total weight handled	56,600 lb.
Weight per lift	1,530 lb.
Lifts per hour	106
Weight per hour	75·8 tons

Handling Pig-iron, Snow-covered and Frozen.

Total weight handled	26,200 lb.
Weight per lift	1,091 lb.
Lifts per hour	120
Weight per hour	65·5 tons

On the assumption that the crane ran 50 per cent. of the time only, the owners gave the costs set out below:—

Magnet interest at 5 per cent.	£12	10	0
Magnet depreciation at 10 per cent.	25	0	0
Current charges for magnet	24	[illegible]	0
Crane interest at 6 per cent.	[illegible]	10	0
Repairs	129	[illegible]	[illegible]
Depreciation for crane	57	10	0
[illegible]	300	0	0
[illegible]	750	0	0
Total	£1,37[illegible]	[illegible]	[illegible]

The cost per ton, therefore, of handling the material is: light scrap, 1·[illegible]d.; heavy scrap, 1·11d.; and pig iron, 1·[illegible]d. This includes labour for trimming the charging boxes.

Rough figures obtained subsequently showed that the loading of pig iron from a pile into charging boxes could be carried out at a cost somewhat less than 1d. per ton, covering all the irregularities and disadvantageous conditions that might arise.

A firm of manufacturers estimate that users of their lifting magnets are now making a direct saving of about half a million sterling annually in labour costs alone, and it is said to be no uncommon occurrence for a single magnet to effect a saving of from £2 to £8 per day.

In analysing the above figures it should be noted that the costs refer to American practice, and that almost one half of the total cost is contained in the item covering stockers' wages. The makers point out that the cost of unloading pig-iron, which used to be contract work at 4d. per ton, would therefore be in the neighbourhood of 0·5d. per ton. Wages in the United States are higher than in this country, and the amount for repairs is greater than one would allow for a small crane working under the conditions ruling at home. A factor at least as important as the reduction of operating costs is the elimination of unskilled labour.

It is reported that a cargo of 1,960 tons of pig iron was unloaded in $10\frac{1}{2}$ hours by means of two 62 in. magnets and two men, the average lift per magnet being 1·53 tons. Formerly it took two days and two nights to clear such a load, and 28 men were required for the work. The unloading of 55 tons of pig iron in half an hour by a 52 in. magnet, with an average load per lift of about 0·84 tons, is another creditable record. Recent improvements in the design of these lifting magnets are said to have increased the lifting capacities from 20 per cent. for some sizes up to 60 per cent. for others, without increasing their weight.

Advantages.—In addition to the direct saving in labour, the following indirect economies may be mentioned :—

(*a*) Ability to pile stock to any height, limited only by the clearance of the crane. This augments the capacity and value of a given stockyard over one served by hand labour, when a stock pile of any considerable height becomes prohibitive owing to the cost of handling material. The introduction of one or more lifting magnets frequently makes it possibly largely to increase the capacity of a given plant without increasing the size of the yard or the number of cranes in service.

(*b*) Ability to make up heats promptly in an open hearth or foundry stockyard, thus increasing the output of the furnaces, decreasing the consumption of fuel in keeping empty furnaces hot, and decreasing the labour and fuel cost per ton of output.

(*c*) Saving in demurrage on railway wagons. It is not at all uncommon for a single operator to unload a 50-ton truck of pig-iron in 15 minutes.

(*d*) Delays in unloading or re-handling stock under unfavourable weather conditions are avoided.

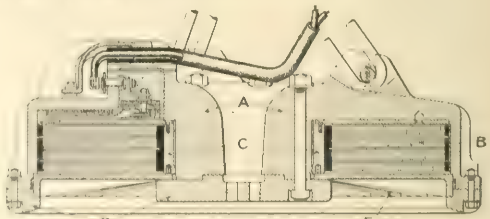


Fig. 2. Section of Igranic Lifting Magnet.

Rating. The lifting capacity of a magnet depends entirely on the materials which it has to handle, particularly, however, on the following: (*a*) The magnetic quality of the load; (*b*) the temperature of the material, which should not be above black heat; (*c*) the shape of the load and whether it consists of one solid piece or a number of small parts; and (*d*) the manner in which the material to be lifted is stacked.

Although the lifting capacity cannot be calculated, it may be assumed that a well-designed magnet is capable of lifting a solid piece of steel, with machined surface, of not less diameter than the magnet itself, weighing approximately 15 times the weight of small magnets, 8 to 12 times the weight of magnets from 2 ft. to 3 ft. in diameter, and 5 to 6 times the weight of magnets from 3 ft. to 5 ft. diameter.

When dealing with materials such as sand-cast pig-iron or heavy scrap, the lifting capacity decreases considerably, depending entirely on the amount of material covered by the contact surface of the magnet. The larger the contact surface the greater the load attracted. With magnets of large diameter, in addition to the first layer, further material is in some instances attracted by the centre pole. When the load consists of iron plates the load depends on the size of the plates, but up to six layers can be lifted according to the thickness and weight of each plate and the type of magnet. The weight of loose materials, such as stampings and drop forgings, attracted by a magnet varies greatly, and is relatively small, in some cases only amounting to about one-half the weight of the magnet.

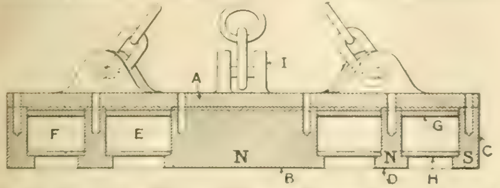


Fig. 3.—Section of "Phœnix" Lifting Magnet (Circular Type).

In order to increase the weight of material handled per lift, a battery of two or more magnets may be used. In such cases the magnets are so suspended from a common bar or frame as to obtain the best results. This arrangement is advisable when handling long pieces or sheets, as the overhang tends to pull the load away from a single large magnet.

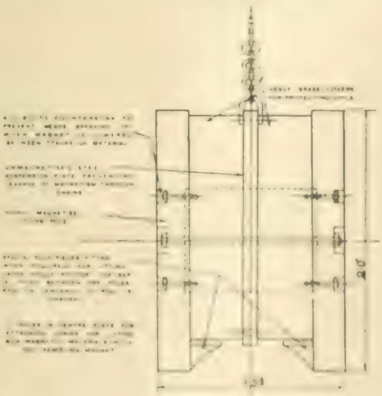


Fig. 4.—"Phœnix" [illegible]

[illegible]

The magnet is permanently waterproof and fire-proof. It is provided with a renewable bottom-plate of manganese steel, which may be easily removed and replaced without exposing or disturbing the coil in any way. The coil cannot move in the case, and it is cushioned against the effect of hammer blows by the double bottom-plate construction. Ribs on the top and sides serve to stiffen the magnet case and to augment the cooling surface. The large cored hole in the centre pole acts as a very effective ventilating duct. Copper strip, heavily insulated with mica and asbestos, is used for the coil. It is wound directly upon a flanged metal spool and is thoroughly impregnated. The spool construction makes the coil a rigid unit that may be handled without danger of mechanical injury. The coil terminals are spaced 120 deg. apart; they are moulded into heavy high-voltage insulators babbitted into the case, and the terminal cavities are large so as to allow for expansion and contraction of the compound. This construction gives 4 in. of insulating compound between terminals as a protection against short circuits.

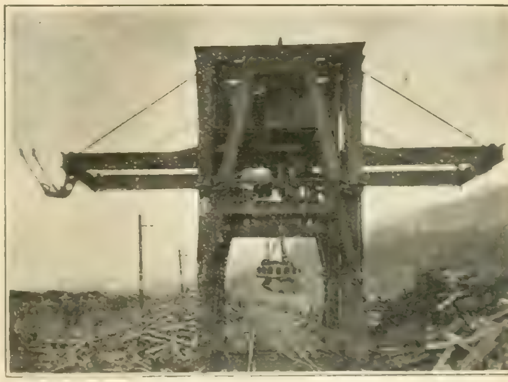


Fig. 5.—Witton-Kramer Scrap Handling Magnet Crane.

A section of the well-known [illegible] lifting magnet is given in Fig. 2. The body or frame [illegible] is provided with heavy lugs cast integral with it for the suspension chains, and the terminal box is likewise part of the casting. Both the inner and outer pole-shoes D are strong steel castings, and are secured to the frame by through bolts. [illegible]

[illegible]

Co., Westminster, is manufactured by Messrs. Steel Peech & Tozer (Ltd.) at Sheffield, who developed the magnet for use in their own works. The present designs embody all the improvements suggested to them by their experience gained under actual working conditions. This magnet is made in many shapes and sizes, two of which are illustrated in Figs. 3 and 4.

The casing *AC* and poles *NS* (Fig. 3) are made of high permeability cast steel. Between the centre block or pole and the outer wall an intermediate annular wall, *D*, is provided, which divides the winding space into two compartments, *E* and *F*, one coil being wound round the centre pole and the other round the annular piece. This extends the area of the centre pole, and materially increases the lifting capacity when the magnet is handling plates, strips and the like. The coils are wound on brass formers to ensure the windings being kept rigid, as there is a tendency in all magnets during switching on and off for the turns to move slightly. Such movements would in time break down the insulation. Manganese steel bumping plates, *H*, protect the coils from injury.

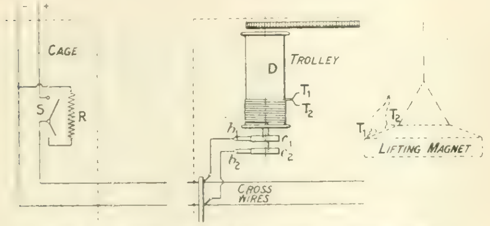


FIG. 6. WIRING DIAGRAM FOR LIFTING MAGNET CIRCUIT.

The special features of this magnet are shown in Fig. 4. An important advantage is that the magnet has provision on the centre lifting plate for the attachment of dogs or slings for lifting non-magnetic material, without detaching the magnet from the crane hook. In the latest design the energising coil is wound out of centre with the pole pieces, and different working faces are given to the magnet. In practice it is necessary in certain classes of work to lift—say four—4 in. blooms, and in other cases eight such blooms. These conditions are met by simply reversing the working face of the magnet, which is accomplished by taking one suspension chain link out and transferring it to the opposite corner, the magnet having four points of suspension on the lifting plate. Thus with one, two or three of these magnets in use, a 16, 32 or 48 in. working face can be given with the magnets slung one way, or 20, 40 or 60 in. face with the magnets arranged the other way. One of these magnets, weighing only 4½ cwt., is said to have lifted quite easily, on the 16 in. face, two billets 7¼ in. by 7¼ in. by [illegible] long, and on the 20 in. face three such billets. Three of the magnets bolted together (total weight [illegible] 14 cwt.) have lifted a 6 ton forging and 10 billets 5¾ in. square by 5 ft. long.

The insulation of these magnets is carried out in a thorough manner. After the magnets are assembled they are vacuum dried and the insulation tested. When the coils are found to [illegible] an insulation test of 200 megohms at 1,000 volts for three [illegible] a valve is opened connecting the vacuum chamber to a vessel which is filled with boiling compound; this is drawn by the vacuum into the drying chamber and consequently into the magnet casing. After standing under these conditions for a period varying according to the size of the magnet, a pressure of 100 lb. per square inch is applied to the top of the compound to ensure complete impregnation and filling of the casing.

The "Ferrolift" magnet can when desired be fitted with a safety device which ensures the retention of the load in the event of the main current supply failing.

Another well-known magnet is the "Witton Kramer," made by the General Electric Co. (Ltd.), and the following notes will serve to give some indication of the good engineering which characterises the design. The magnet consists of an extra heavy high permeability steel case having centre and outer poles of large section, the said poles being detachable. A non-magnetic shield is provided for protecting the coil. The coil is self contained and independently fixed. It consists of former wound strip copper discs, specially treated, insulated from each other, and from the shell by means of highly compressed thick mica plates, mechanically secured by asbestos blocks and non-magnetic bars. The coil is surrounded by an air space, and thus effectively prevented from contact with the shell. The inner and outer ends of coil are brought through an air space into a large terminal box with steel cover, having holes for fixing cable grips. The magnet is provided with two 9-in. watertight steel cable grips attached to the terminal box, and two lengths of single pole leading-in cable, each length of cable terminating in a single-pole barrel socket connector, ready for connection to the magnet cables. The use of two single-pole cables is much more satisfactory than one double-pole cable, as it eliminates the risk of the two copper conductors rubbing against each other, and short-circuiting, as is frequently found in cases where double-pole cables are used.

The nature of the work on which a large number of these magnets are engaged is evident from Fig. 5. Here is shown a specially designed travelling structure, enabling scrap material to be handled on either side of a railway track with great ease.

Method of Control.—A circuit containing an electromagnet is highly inductive and in order to prevent the insulation from breaking-down, provision must be made on switching off for guarding against the induced voltage and for dissipating the energy stored in the magnetic field. The common method is to shunt a discharge resistance across the magnet terminals prior to the opening of the circuit and to disconnect the resistance before switching on.

The controller has three positions—on, off and reverse. In the "off" position the magnet coils are disconnected from the supply and the non-inductive discharge resistance is shunted across its terminals as described above. When the controller handle is placed in the working position the magnet winding is connected direct to the supply, and in turning the handle to the "reverse" position a small current flows through the winding in the reverse direction in order to make the magnet lose its residual magnetism and quickly release the load. The handle can only remain in this reverse position as long as the operator holds it there, and when he releases the handle it automatically returns to the off position.

The most recent practice is to use contactor type controllers and master switch for magnets of large diameter or size.

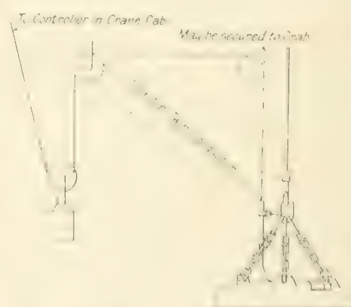


FIG. 7. METHOD OF TAKING CHARGE OF SLACK CABLE.

Connection.—In one method a spring drum is fitted on the crane trolley for automatically coiling and uncoiling the flexible cable through which the current is transmitted to the magnet.

Some users prefer to drive the cable drum from the main drum. Such an arrangement is depicted in Fig. 6. The drum *D*, geared to one of the shafts of the lifting mechanism and provided with two collector rings, c_1, c_2, is mounted on the trolley. The brushes h_1, h_2 are connected to two cross wires, and it is desirable to connect these wires on the live side of the main circuit breaker or fuses.

A further arrangement is to use a counterweight. The method is depicted in Fig. 7, and the twin conductor cable is passed over a sheave attached to the trolley and carried along the bridge over a set of sheaves in the operator's cage, the free end being finally taken to the control switch.

Conveyors and Elevators.

By W. H. ATHERTON, M.Sc., M.I.Mech.E.

Summary. The development of the conveyor and elevator for the handling of coal [illegible] requirements are considered in detail. Sufficient coal storage is a vital matter for the power station, [illegible] which are conveniently solved by conveyors. The various types of conveyors and elevators for coal handling [illegible] considered in some detail, and reference is also made to the suction method of removing ashes.

In the earlier types of boiler houses it was usual to discharge coal from carts on to the firing floor placed a few feet below the street level, the only coal storage space being that in front of the boilers. The coal was lifted up by shovels and discharged either direct into the boiler furnaces, or thrown into small cast-iron hoppers feeding mechanical stokers. The ashes and clinker were removed in barrows and dumped into the yard, from which they were shovelled by hand labour into carts. All this handling of coal and ashes by manual labour was extremely wasteful, and could only be tolerated when labourers were cheap and plentiful, and boiler houses were of small capacity.

As power stations developed in size, the need for reducing the amount of hand labour became of great financial importance. The first step was to arrange for the coal to be dumped into a receiving hopper at one end of the boiler house; from which it was raised without hand labour by an endless chain and bucket elevator, delivering into a continuous conveyor of the scraper or push-plate type, running over a series of small hoppers fixed to the front of the boilers, and supplying mechanical stokers through openings controlled by sliding doors. This simple method of saving labour is shown in the general arrangement (Fig. 1), it being a very convenient and suitable scheme for boiler houses of small or moderate size.

The need for additional coal storage may be met either by building a storage hopper at the ground level, or by fixing overhead storage hoppers, the latter being now the usual method. The first cost of overhead hoppers is high; but apart from this consideration the necessary headroom is seldom available in existing boiler houses. The alternative arrangement of a storage hopper on the ground was adopted at the Grimsby Corporation Electricity Works and is shown in Fig. 2. A conveyor of the scraper type is fixed in front of the coal store and is fed by a series of chutes from the latter. The conveyor delivers the small coal into the [illegible] elevator which in turn delivers the coal through an Avery automatic weighing machine into the scraper conveyor running over the stoker hoppers. This conveying plant was erected in the year 1906 and [illegible] small [illegible] method of taking the coal from the coal stores and delivering it in known quantity into the boiler furnaces.

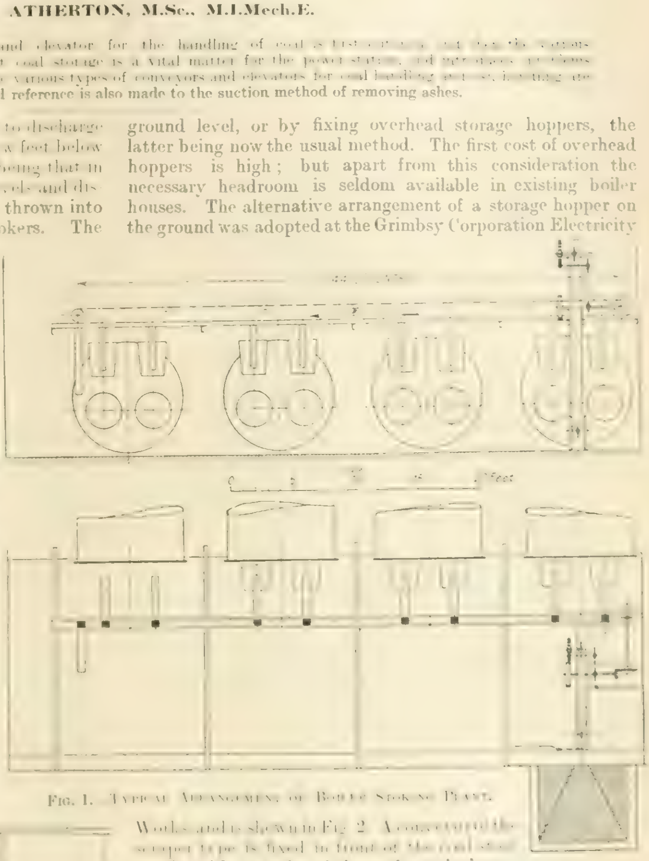


Fig. 1.—Typical Arrangement of Boiler Stoking Plant.

The wear and tear on the bottom of pressed steel conveyor troughs is fairly heavy, and it is, therefore, advisable to line the trough with a renewable lining plate. Instead of pressed steel troughs [illegible] iron trough with flanged bolted joints. With steel at the present [illegible] cast iron for this purpose than pressed steel. An example of [illegible]

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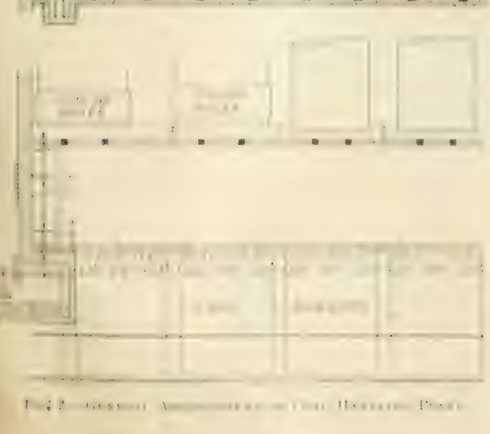


Fig. 2.—[illegible]

alternatively either of cast-iron plates or of reinforced concrete, the latter being very durable, but extremely heavy. In Fig. 4 an inclined bucket elevator delivers into a scraper conveyor running over the coal-storage bunkers, from which long chutes lead the coal to the stoker hoppers feeding the chain-grate furnaces. These chutes are often fitted with gear for measuring the volume of coal passing from the bunkers

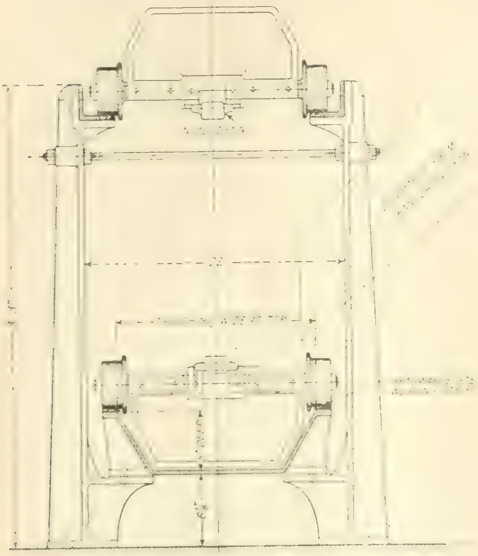


Fig. 3.—Cross Section of Scraper Conveyor.

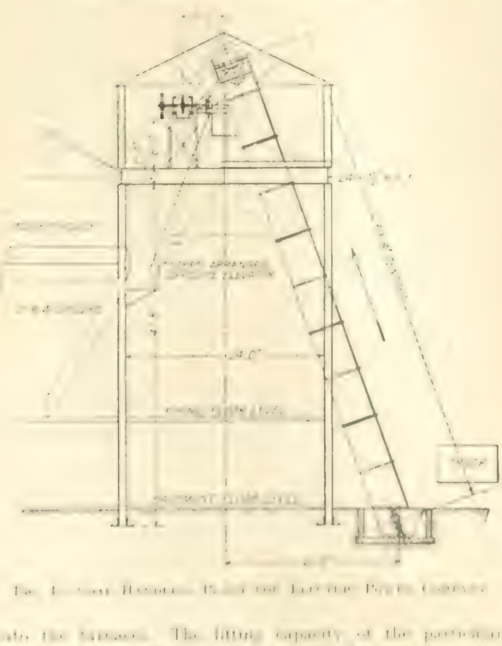
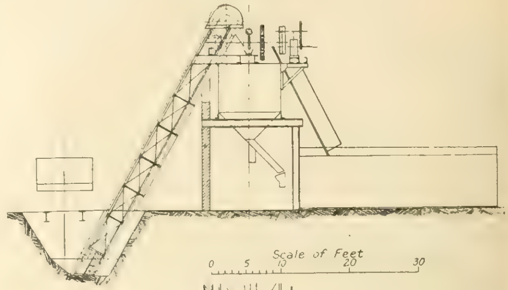


Fig. 4.—Coal Handling Plant for [illegible]

into the furnaces. The lifting capacity of the particular conveyor shown is 30 tons per hour. The buckets are malleable iron, [illegible] long, with thickened lip, and are bolted to a single strand of malleable iron pin chain of 6 in. pitch.

Fig. 5 is a [illegible] for a pair of inclined lattice framed coal elevators feeding two conveyors running over storage hoppers serving 20 Lancashire boilers. The coal is fed from coal-trucks into receiving pits provided with doors for regulating the admission of coal to the elevator boots.



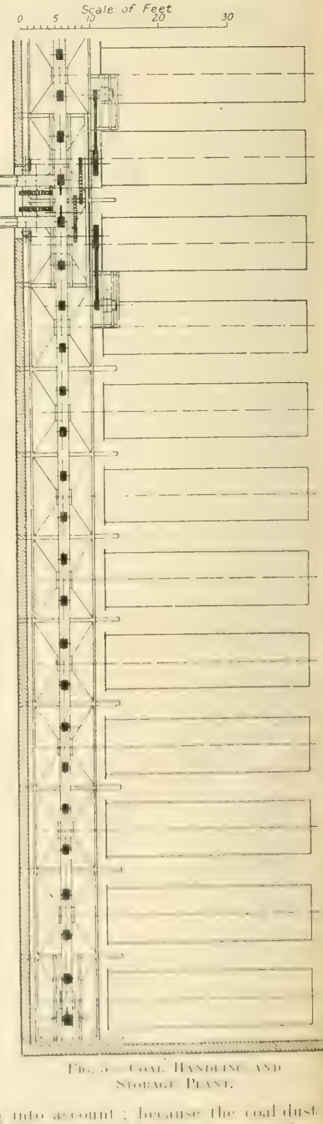


Fig. 5.—Coal Handling and Storage Plant.

Fig. 6 is a cross-section of a scraper conveyor of heavier type for the distribution of coal into overhead storage hoppers. This conveyor has a capacity of 50 tons of coal per hour. The trough is built up of steel plates and angles and is fitted with a renewable lining plate $\frac{1}{4}$ in. thick. There is a clearance of about $\frac{1}{2}$ in. between the scraper plates and the bottom of the trough; the scrapers being bolted to malleable iron crossbars with turned ends, on which revolve cast-iron rollers fitted with special oilless bushes. These are intended to obviate oil lubrication by utilising the lubricating properties of graphite.

The best method of lubricating conveyor rollers is a moot point, and it is doubtful whether this method is much better than a simple oil hole and the intelligent use of an oil can, taking everything into account; because the coal dust collects, cakes on and renders useless all lubricators, unless more than ordinary attention is given to them. Some other methods of lubricating rollers are as follows.

(a) To put grease lubricators on every roller.

(b) To fit lubricators to the ends of the spindles, which may be bored up.

(c) To use hollow rollers containing oil wells.

(d) To use oil reservoirs and wipers giving a constant supply of oil on to the rollers, but this is liable to be wasteful of oil.

The upper part of the inclined elevator feeding the scraper conveyor is also shown in Fig. 6. The buckets are of malleable cast iron 18 in. long, bolted at intervals of 24 in. to a single strand of chain (No. 6140) of the Ley bushed type

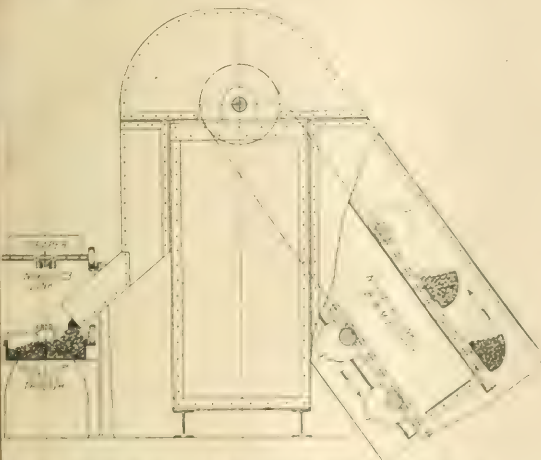


Fig. 6.—Cross Section of Scraper Conveyor and Elevator.

fitted with steel pins and hardened steel renewable bushes. The crossbars are furnished with cast-iron bushed rollers, 6 in. diameter, running on angle iron tracks. The elevator top shaft is 4 in. diameter and the main sprocket wheel 28 in. diameter, made of hard chilled metal. A peculiarity of this elevator is that there is no spur wheel and pinion at the top of the elevator, but it is driven direct by a chain of the Ley grip type. On one end of the top shaft is keyed a toothless or grooved friction wheel 60 in. diameter (shown in section (Fig. 7), which is geared to a sprocket wheel 12 in. diameter

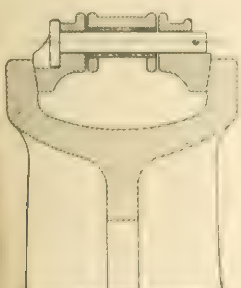


Fig. 7.—Grooved Friction Wheel.

Fig. 8.—Ley Bushed Chain.

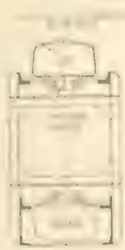


Fig. 9.—Cross Section of Open Elevator.

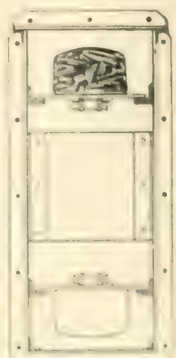


Fig. 10.—Cross Section of Cased Elevator.

on the driving shaft by a grip chain provided with wedge-shaped friction pieces. In this way a large ratio of reduction is quite feasible and the drive is a very smooth one. If a large sprocket wheel were used on the top shaft it would have the objection that, as the chain links increased in pitch by wear the chain would gradually rise to the tops of the teeth and eventually give trouble and finish by slipping over the teeth.

The Ley bushed chain shown in Fig. 8, is a type of standardised chain very largely used for coal elevators, especially in gas works, collieries and power stations, the wearing parts being readily renewable. The lugs cast on the attachment links afford a good seating for the buckets, bolts being generally used for fastening rather than rivets.

Coal elevators are made either with an open lattice steel framing having a dust trough below, as shown in the cross section (Fig. 9), or alternatively the chain and buckets are completely enclosed in a sheet steel casing, which may be either straight or curved. Sometimes cast-iron is used, especially for vertical elevators. A cross section of a cased elevator is given in Fig. 10. Casings are used to keep down the dust and to protect the running gear against the weather. Cased elevators are more expensive than lattice framed elevators of the same capacity, and at the present time there is much difficulty in obtaining the steel sheets necessary for their construction. Fig. 11 illustrates a neat form of curved elevator of the open type, as designed for raising and delivering ashes into railway trucks, with a minimum of labour. To relieve the wear on the guide angles a plain roller is fitted at the bend.

The Capacity of Elevators

The lifting capacity or tonnage rate of an elevator is governed by at least six things, or is a function of six variables, viz. :—

(a) *The size of the buckets*, which varies in single strand elevators from about 6 in. to 24 in. in length, and from about 64 to 2,200 cubic in. in capacity.

(b) *The pitch of the buckets*, which varies from about 1 ft. to 3 ft.

(c) *The speed of the buckets*, which varies from about 60 ft. to 180 ft. per minute or more. An inclined elevator can be run at a lower speed than a vertical elevator and still give a cleaner delivery; for the reason that in an inclined elevator the delivery chute can be placed vertically below the point of discharge.

(d) *The rate of feeding*, which should be as regular as possible. If the feed is irregular some buckets will go up full, some half-full and others empty; thus the full capacity of the elevator is not obtained. When elevators are fed from coal breakers and stone crushers the rate of feeding is necessarily very irregular. This means that much larger buckets must be used than the average hourly capacity of the elevator would otherwise require. During short periods of feeding the momentary rate of working may be 100 tons per hour, while the average rate of working may not be more than 30 tons per hour. The buckets must, therefore, be large, otherwise the elevator will be flooded and spilling will occur.

(e) *The density of the material*, or number of pounds per cubic foot. The heavier the material the greater the loading tonnage, other things being equal; but of course light materials, such as grain, are commonly lifted at a higher lineal speed than heavy materials, such as coal and ore.

(f) *The size of the pieces of material.* The smaller the pieces the better the material fills the buckets and the smaller the air spaces or gaps between the pieces. Large pieces of coal or stone do not pack well, and they require large buckets simply to accommodate them without jamming or danger of

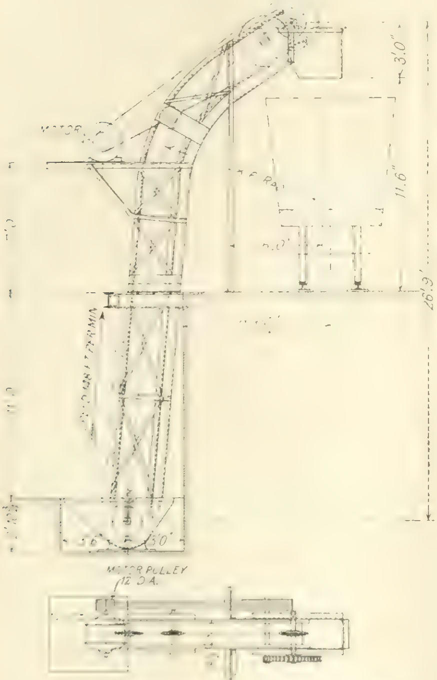


FIG. 11.—ARRANGEMENT OF CURVED ELEVATOR.

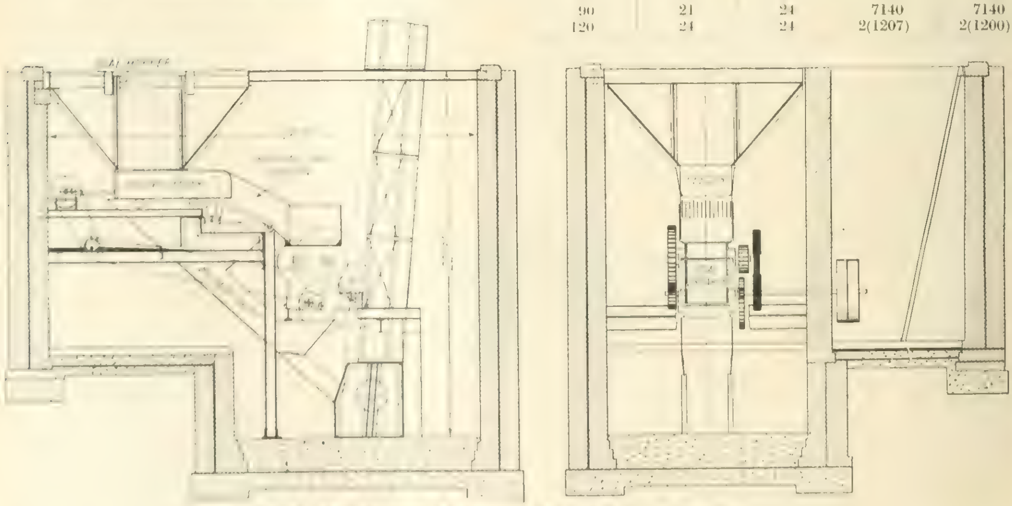


FIG. 12.—ARRANGEMENT OF BREAKER PIT AND FOOT OF ELEVATOR.

falling out quite apart from the number of tons per hour to be lifted. This elementary fact is too often overlooked by purchasers.

In addition to these six well-defined factors, the lifting capacity of an elevator is also influenced by the shape of the buckets, the inclination of the elevator and the physical condition of the material as to wetness and viscosity. It is well known that damp fine coal is a troublesome material to lift, because it will not flow at all freely, but hangs up or bridges over, and stops feeding. Also damp coal dust clings to the buckets and forms an internal incrustation, which greatly reduces the effective capacity of the buckets. In like manner sticky materials, such as moist sugar, wet lime, clay and mud require buckets of special shape and cause trouble from hanging up and caking on. In fact the buckets have to be cleaned out from time to time. There are many pitfalls that beset the conveyor engineer, owing to the variability of the physical properties of the various materials handled and the peculiarities of the conditions of operation.

When material is fed to an elevator from a large bottom hopper some means of regulating the rate of feeding is convenient if not necessary, such as a sliding door, a jigging feeder, or a rotary feeder. In cases where a few large pieces of coal are mixed with much small coal, a grid may be used to intercept the lumps instead of using a coal breaker. In gas-works, however, a four-roll coal breaker is generally used in connection with coal elevators to reduce large lumps to a size of about 2 in. cube before carbonising. Fig. 12 shows a complete arrangement of breaker pit with feeding hopper, jigger and by-pass chute for taking small coal direct to the elevator boot without passing through the breaker.

It may be useful to introduce here in tabular form a rough suggestion as to the safe sizes of buckets and chains for various capacities of coal elevators inclined at 60 deg. to 70 deg. and fitted with heavy malleable cast-iron buckets of standard type, as used in gas works, collieries and power houses. Only the 24 in. buckets need two strands of chain.

Tons of coal per hour.	Length of buckets "B" type. ins.	Pitch of buckets. ins.	Suitable Ley Chain. Long elevator. Ref. No.	Suitable Ley Chain. Short elevator. Ref. No.
5	6	16	578	88
10	8	18	503	578
15	10	18	500	503
25	12	18	600	500
40	15	18	6140	600
60	18	24	7140	6140
90	21	24	7140	7140
120	24	24	2(1207)	2(1200)

COAL STORAGE.

The question of providing external coal storage in addition to the coal carried inside the boiler house has assumed great importance since the coal strike in 1911, and it is now usual to carry much larger stocks of coal than were formerly

considered necessary. This means locking up a large amount of capital, but it is distinctly better than having to close down a power station altogether during a period of stress. In power houses of small and moderate size the coal is often simply stacked in the yard, and when supplies run short the shortage is made good by carting or wheeling coal in barrows from the heap in the yard.

In laying out a large power station one big problem is to design the most economical means of delivering coal into the main coal store and of taking coal from the store into the boiler house. It is not advisable to arrange a plant so that all the coal must of necessity be delivered into the coal store before it can be taken into the boiler house, as this would mean double handling of every ton of coal burnt. On the contrary, when the coal store is filled it should be possible to leave the coal undisturbed and take the new supplies of coal direct into the boiler house bunkers. Some important designs are faulty in this respect.

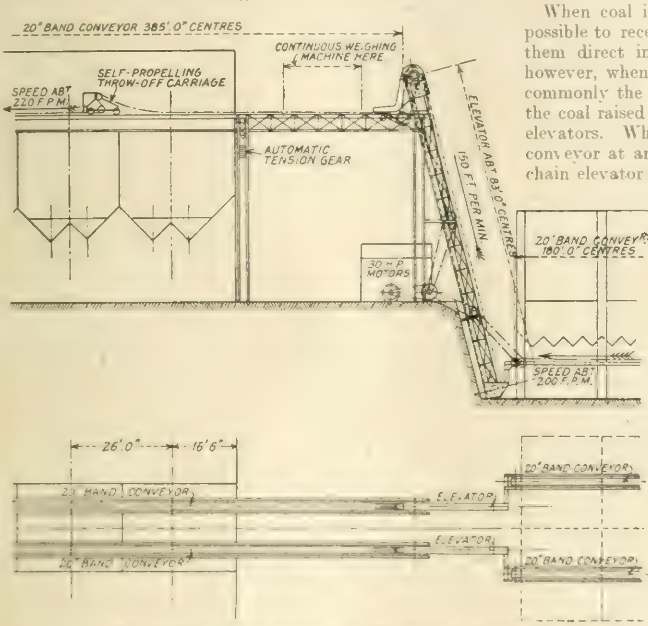


Fig. 13.—Arrangement of Coal Handling Plant.

There is no general solution of the problem in question, because the conditions of the site vary so greatly, and to a less extent the character of the supplies available. When the coal is received in barges it is usual to unload the coal by grabs operated either by ordinary travelling jib cranes or by transporters, the latter being especially useful when the horizontal distance to be traversed is considerable. Other methods are to use small trucks or overhead electric telphers or ropeways.

Movable bucket elevators with hinged jibs have also been adopted to a limited extent for unloading coal from barges; but they are less flexible in operation than grab cranes, and more troublesome in dealing with lumpy coal. The variation in the immersion of the barge between full load and no load is also a point of difficulty, as well as the variation in the height of the tide in the case of tidal rivers. These inconveniences do not affect grab cranes to the same extent.

When coal is delivered in railway trucks it is sometimes possible to receive these trucks at a high level and discharge them direct into the coal bunkers. This is only feasible, however, when the coal store is situated in a valley. More commonly the trucks are discharged into track hoppers, and the coal raised to the top of the storage bunkers by means of elevators. Where ample ground space is available a band conveyor at an easy inclination can be applied instead of a chain elevator and the same conveyor continued horizontally over the bunkers. A coal breaker is required, placed generally below the track hopper, to reduce the large lumps of coal to convenient dimensions. Preferably [illegible] should be in duplicate.

Fig. 13 shows one design of coal handling plant, in which coal is conveyed from outside storage bunkers to the boiler house by means of band conveyors and bucket elevators. The scheme shown includes duplicate 20-in. band conveyors taking coal from the outside bunkers to the boots of the elevators, a cross section of the conveyors being given in Fig. 14. The coal is then lifted by a pair of elevators, 83 ft. centres, fitted with 15 in. buckets, each elevator having a capacity of 40 tons of coal per hour. The elevators deliver on to a pair of 20-in. band conveyors running at 220 ft. per minute, distributing coal into overhead bunkers. The belt is of canvas, 6-ply thick, [illegible] with rubber.

A self-propelled travelling throw-off carriage or tripper enables the coal to be discharged throughout the whole length of the range of hoppers. This is so arranged with symmetrical chutes and hinged doors that the coal can be delivered equally on both sides of the belt, or returned to the belt when it is desired to pass the coal over the end of the belt or to another tripper, a second tripper being desirable on a long conveyor. The coal carried by the distributing band conveyors can be weighed by means of two Blake-Denison continuous weighers. These [illegible] automatic [illegible] machines for weighing coal while in motion [illegible] [illegible] with the hopper [illegible].

Fig. 14.—Cross Section of Conveyors over Bunkers. [illegible]

(To be concluded.)

Telphers and Transporters:

By GEORGE FREDERICK ZIMMER, A.M.Inst.C.E.

Summary.—After comparing the merits of the telpher and the conveyer, a general description is given of the two types of telpher at present in use, and their respective merits are stated. In the telpher track the switch is a most important component, and much ingenuity has been expended in perfecting this part of the equipment. Finally, some typical examples of telphers are described in detail, and some indication is given of the performance that may be expected.

The writer feels gratified at the permission to contribute his quota to this special publication of The Electrician, not only because it deals with his pet subject, but particularly because he feels that the time has now come when we are beginning to awake from our national lethargy, and when those who missed the opportunity of installing handling machinery before the war may realise their mistakes. It is only the few nowadays, who, fortified with Priority Certificates, are able to obtain such machines, and the rest will have to wait until this bloody war is over and peace reigns once more. There must be a boom in handling machinery then, for not only shall we have to increase the output of our industrial undertakings to at least what it was in pre-war time—and that with considerably fewer men—but we shall have to find employment for the heroes who return, permanently maimed, to their homes, and what better conceivable work can we find for such men of the labouring classes than to drive a telpher or transporter, sitting the while in their comfortable cabins. As for the rest of our workers, they will in future no longer be beasts of burden; we shall thus be compelled to employ the machine to do the hard work of handling and let the men be the brains of these machines.

"The telpher," as Mr. Streeter well expresses it, "does practically the same work for an entire industrial plant which an overhead travelling crane does for an individual shop." But the writer would add that whereas the former can be compared to and is often called Goliath—strong but slow—the latter might be likened to David—light, quick and agile.

The name telpher signifies the application of electricity as motive power to vehicles on an overhead track. The credit of the invention is due to the late Prof. Fleeming Jenkin, M.Inst.C.E. The name was chosen by him and is derived from the Greek *tele*—far, and *pherein*, to bear, to carry.

Justification of the Telpher.

Telphers are, comparatively speaking, new devices; we must therefore first justify their existence.

When material has to be conveyed mechanically, say from a railway siding or the quay to a works in a straight line, a continuous conveyer is, in the writer's opinion (with certain reservations), the most scientific and most economical device, because a continuous conveyer receives and delivers its load in a uniform and continuous stream, and though this stream of coal, or whatever the material, may look small and insignificant, and its progress slow, yet its continued action soon accumulates prodigious quantities. The weight of such a conveyer per yard is, therefore, the same for the whole of its length, and a light structure will easily support it. A telpher or transporter, on the other hand, can negotiate curves and is an intermittently working machine; that is to say, the net loads, usually of from ½ to 1 ton, are conveyed along an overhead track at certain intervals, which means concentrated moving loads, and the support for such an installation must therefore be a very substantial structure, and consequently more costly than the track support for the continuous conveyer. Take, for instance, a continuous conveyer of a given capacity, together with its foundations and supports; it may cost from £3 to £5 per foot run, lock, stock and barrel. A telpher track for the same performance, including, however, the track only, will cost from £3 to £4 per foot, and each telpher machine about £150 to £500, according to duty.

One of the greatest drawbacks of an intermittent machine is that it has always to return empty for a fresh load, whereas the continuous conveyer is never idle.

Continuous conveyers have also their disadvantages. To begin with, they are, as we have seen, confined to work in a straight line, either horizontally or at a slight incline up or down, while the telpher track can be laid in all directions, in and out between buildings and up and down gradients. A continuous conveyer must be fed by some device, as it cannot pick up its own load out of a railway truck or a vessel, as can be done by a telpher. A continuous conveyer can, too, as a rule, only work in one direction, and only handle one kind of material, while a telpher can run backward and forward, up hill and down dale, pick up any material anywhere and drop it again wherever wanted along its track. We thus see that the existence of a telpher is fully justified, and that it fills, moreover, an important office in the art of handling by machinery.

If a continuous conveyer is cheaper in its initial cost we have to debit its account with the loading device, and if, as in gas works, we have to bring coal in and coke out of the yard, we should have to employ the continuous conveyer and the loading device in duplicate, while the telpher could perform the whole programme unaided except by its driver.

General Remarks Concerning the Telpher.

The telpher, transporter, or mono-rail system of conveying is by electric overhead trollies, and is one of the most economical methods of handling, as the loading, hoisting, conveying and unloading are all under the control of one man, whether he accompanies the telpher in his cab or whether he operates it from a stationary cabin. The longer the haul the greater the economy, and this method of conveying should, therefore, recommend itself particularly for long distances, where continuous conveyers, such as band, push-plate, gravity-bucket and tipping-tray will no longer be applicable except in series (the distance being too great for one unit) or where the direction of the path to be traversed is tortuous, and cannot, therefore, be negotiated by most of the continuous types of conveyer, or finally where different materials have to be handled by the same appliance.

The overhead track on which the telpher machine runs, with its supporting structure, is the principal expense of such an installation, and this part of the plant is not subject to any wear and tear, except the rail or track itself.

The telpher track may be laid across roadways, yards, rivers and other waterways; in fact most places where it would be impracticable or impossible to lay light railways, or indeed any other kind of conveyors, without interfering with the traffic. The track may always be extended without any interference with the existing installation, and if there is a return track to the starting terminus there is practically no limit to the capacity of the plant, as the number of telpher machines which may run on the same track is great, as long as they always run in the same direction with a safe distance between, and not backward and forward as would be the case with the single track. Extra flexibility can be gained by the judicious employment of switches, spur-tracks, turn-tables and transfer bridges.

The essential features of a telpher should be the cutting down of unproductive labour expenses, compact design in order to occupy little space, high operating speed, simplicity of control and low initial and working cost.

Among the uses of the telpher are intercommunication between the different departments of industrial establishments, handling material in workshops, munition factories, foundries and warehouses; handling coal, coke and ashes in gas and

power undertakings; loading and unloading vessels, handling merchandise and passengers' luggage in goods stations and docks.

Telphers may be divided into two principal types, all supported on standard I-beams, viz.:—

A. *The Bottom-Flange Telpher*, sometimes called runway, and

B. *The Mono-Rail Telpher.*

Great diversity of opinion exists as to which is the best. There is also a further distinction to be made which refers to both types, and that is that they may either be man telphers—being accompanied by a driver, who from his cab controls all movements—or they may be automatic telphers, which are unaccompanied by a man and are controlled from any fixed point or number of points; and, lastly, telphers may be fitted with a winding gear to raise and lower loads.

Perhaps the most commonly used is type A, in which the trolly operates on the lower flange of a standard I-beam. In type B the trolley runs on a standard rail-track secured to the top of the I-beam, and in a modification of type A two standard rail-tracks are sometimes employed secured to a wide steel plate which is riveted to the base of the I-beam, these two rails being clear of the I-beam proper. In the writer's opinion only the second type (Type B) can lay claim to the name of mono-rail.

Type A is the least expensive to build and to install, as the I-beam may be riveted or bolted direct to any overhead support. The trolley with its connection to the frame of the machine is simple, and the application of the live rail is likewise more convenient.

Type B is supported by a central rail only, and runs, therefore, with greater freedom, and may be run at a higher speed. The greatest advantage of this system is that in it, together with the modification of Type A, no wear can take place on the beam which supports the load, as the standard rails may always be renewed with little trouble, and the structure is not weakened in any way.

The Telpher Track

With a telpher for 3-ton net loads, running on the bottom flange, running strips would be an absolute indispensability; such running strips would have to be tapered so as to convert the incline of the bottom flange of the girder into a level path, but we find that these running strips, even if 1 in. thick at the outside of the girder flange, will stretch and pucker under the constant strain of the weight of a heavy telpher, thus making the path uneven. Without the running strips the bottom flange will very soon show signs of wear, and since the bottom flange is the most important member (the tension member) it would be unsafe to permit any wear, as it would weaken the girder. These remarks do not refer to loads of 1 ton and under. The curved part of a mono-rail track will require renewing after 3 or 4 years in ordinary gas works practice, while the straight part will last from 5 to 6 years. A bottom-flange telpher track is undoubtedly an easier one to erect, as the supporting girder can be simply bolted to the upper supports as already mentioned, and need not be cantilevered down as is necessary for a top-rail telpher track. On the other hand, the weak point of a telpher machine on the bottom flange is that the spindles for the running wheels must be on overhanging pins and therefore in single shear.

Track Curves

A top-rail telpher will negotiate smaller curves more satisfactorily, with greater freedom, and with less wheel grinding than a bottom-rail telpher, just as a bicycle can take a smaller curve than a four-wheel vehicle.

These track curves may be small (the smallest known to the writer being 7 ft.), but radii of less than 10 ft. should be avoided; in fact, the larger the radius the better for the working of the machine, for in order to negotiate a curve with a small radius the driver has to slow down, whereby time is lost and wheel grinding cannot be avoided, which is not only a waste of energy and material, but also produces unpleasant noises. A radius of 20 ft. can be negotiated without slowing down. Another matter to be considered when small radii are concerned is the centrifugal force which comes into play and diverges the whole machine, pendulum-like, and particularly the receptacle for the load, out of its proper path. This means that a very considerable clearance must be allowed between the track and the factory buildings to prevent collisions. Centrifugal force is particularly objectionable when a two-rope grab is used as a receptacle, for if a sharp turn is traversed the centrifugal action on the machine has a tendency to shorten one of the ropes and lengthen the other, and it does happen occasionally that the grab begins to open slightly and thus allows some of its load to dribble out. It may suffice for the reader to know that small radii are permissible, if necessary, but should be avoided as much as possible.

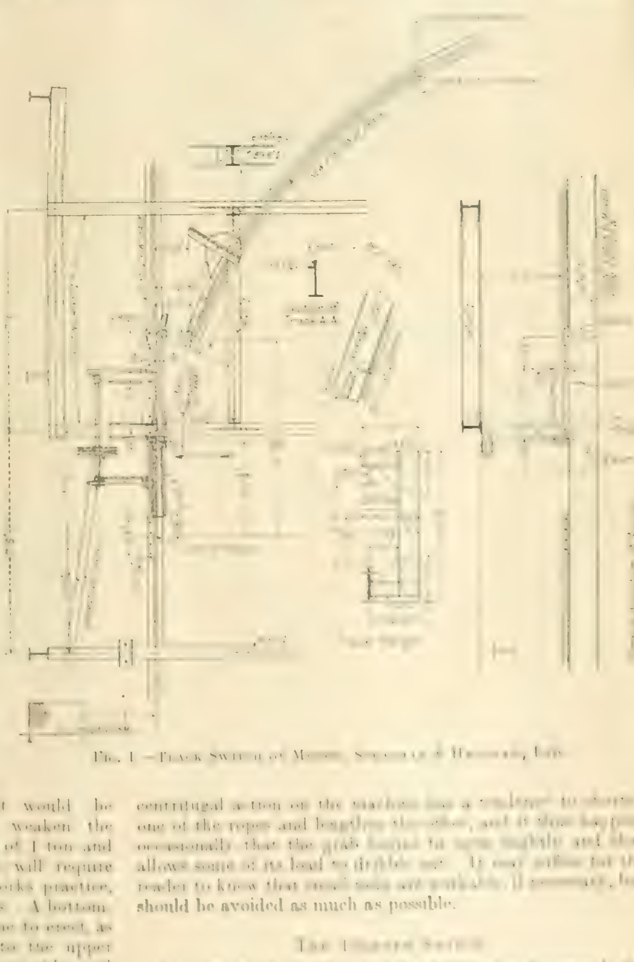


Fig. 1.—Track Switch of Messrs. Strachan & Henshaw, Ltd.

The Telpher Switch

As the field of usefulness of the telpher has increased, the track has become more complex in order to serve a greater number of purposes, and this has necessitated the introduction of a switch. Now a safe and reliable telpher switch is not by any means a simple problem. It must be substantially supported and accurately fixed so that it can be negotiated without any shock to the machine, and this is the most difficult problem; it must be easily and quickly worked, preferably by the telpher man without leaving his cab, and above all it

[illegible] so that the driver in his cab, sometimes 40 ft. or even 60 ft. above the ground will be sure that he does not run off the open end of the switch. We may, however, rest content that the makers now provide all kinds of ingenious devices for the safety of the driver and his load, including mechanical stops, arrangements to cut out the current automatically when the machine approaches an open switch, as well as danger signals. Suitable provision must be made in the overhead trolley wire equipment which must operate simultaneously with the switch of the track or the telpher will come to a standstill. These are the general conditions, but we will enter into details later.

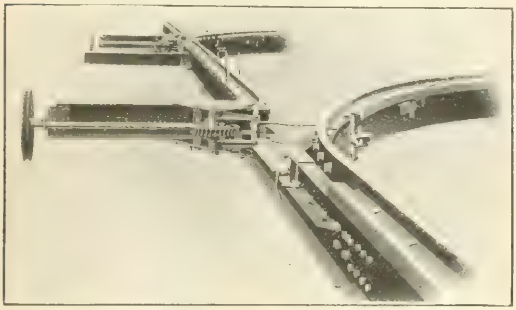


FIG. 2.—DEMPSTER'S "SPRING-WEB" SWITCH SET FOR NEGOTIATING SIDING.

Track switches are built on two distinct principles. Much ingenuity has been lavished on their design. A switch of an ordinary rail-track on the ground is a comparatively simple matter, as there is no difficulty in supporting it on *terra firma*, but the telpher track is high up in the air, and a load of from 5 to 8 tons may be passing over such a switch which therefore requires a substantial support. Now it is obvious that the main girder support should be retained intact, as it is the mainstay of the track, but this is impossible in the case of a bottom-flange telpher, while it is far from simple with a top rail system.

The two principles mentioned above are :—

I. The attachment of a switch on top of a girder without cutting away the girder itself, and

II. The insertion of a switch into a space after the removal of the original girder at the position of junction.

The track switch of Messrs. Strachan & Henshaw, Ltd., belongs to the first category. The switch will best be understood from Fig. 1, which represents it in plan and elevation. From this drawing it will be seen that the movable part of the switch consists of two portions which are moved whilst resting on the main girder. The operation of the switch is as follows :— The half-revolution of the chain-wheel on its spindle operates the chain-wheel which can be fixed in any convenient spot as long as the chain running between them comes within easy reach of the telpher man. The switch can be operated with the application of a force of about 17 lb., through an angle of 240°, and the time required for this is only about 2 seconds.

The two main types of switch belonging to Class II. are what are known as the "Tumbler" or turnover switch, and the very attractive "Spring-web" switch of Dempster's (patented jointly in the names of W. Hargreave and Robert Dempster).

The "Tumbler" or turnover switch is equally applicable to the top-rail and to the bottom-flange telpher. The portion which changes the direction of the track consists of two sections, one of which forms the continuation of the main track, and the other forms the bent portion leading from the main to the siding track. These two sections are mounted rigidly on to a spindle in such a way that they form an angle of about 90° to each other. The spindle which supports these two combined track sections is supported by two bearings fixed to both ends of the main track and parallel with it; thus by turning this spindle through an angle of about 90° either of the two tracks can be completed, the portion not in use being well out of the way.

The "Spring-web" switch (*see* Figs. 2 and 3) consists of a laminated element, constructed of two spring-steel plates, $\frac{3}{8}$ in. thick, with a mild steel packing plate between, at the base of the web, while between the top edges is bolted a piece of track rail, the bottom flange removed by planing. The rail-head is cut obliquely by a saw into short lengths, which gives it the necessary flexibility with the web plates to be moved either into the straight or into the curved position. The saw cuts do not extend beyond the bulb head, thus leaving the web intact. It is secured and supported between the planed edges of the two spring-steel plates. The switch plates are bolted to the web of the track joist at one end and the rail-head fish-plate to the adjacent track-rail, thus producing at one end of the switch a continuous rail joint, whilst the other end of the blade is free to be worked over from the straight to the branch track as required. The writer has seen one of the earlier types of this switch which has been at work for about two years and which has given every satisfaction. Owing to the difficulty of bending this part of the track the switch is only suitable for large radii. The switches are provided and fitted with interlocking gears and catches and a very effective automatic stop for protecting the two open ends of the track (*see* illustrations, Figs. 2 and 3).

A telpher switch is described by Mr. R. L. Streeter* in connection with a mono-rail telpher plant at the Detroit works of Messrs. Dodge Bros., which also belongs to the same category. This telpher plant was erected by the Shaw Electric Crane Co. When a spur is taken from the main line the I girders are so cut that there are three ends near the point of tangency of the centre line of the beams. A cast-steel piece is secured to the end of each of the three beams, the projecting portion of which is on the same level as the bottom flange of the I beam, and constitutes a continuation of the same. On approaching a track switch at which the operator desires to run from the main line to the spur track, he pulls a steering lever placed on the trolley near the controller. This

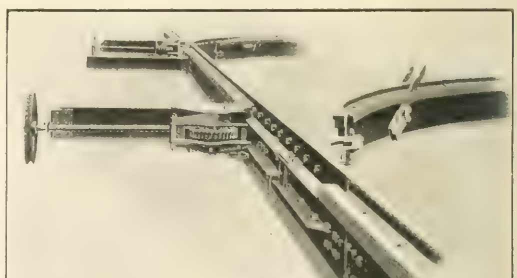
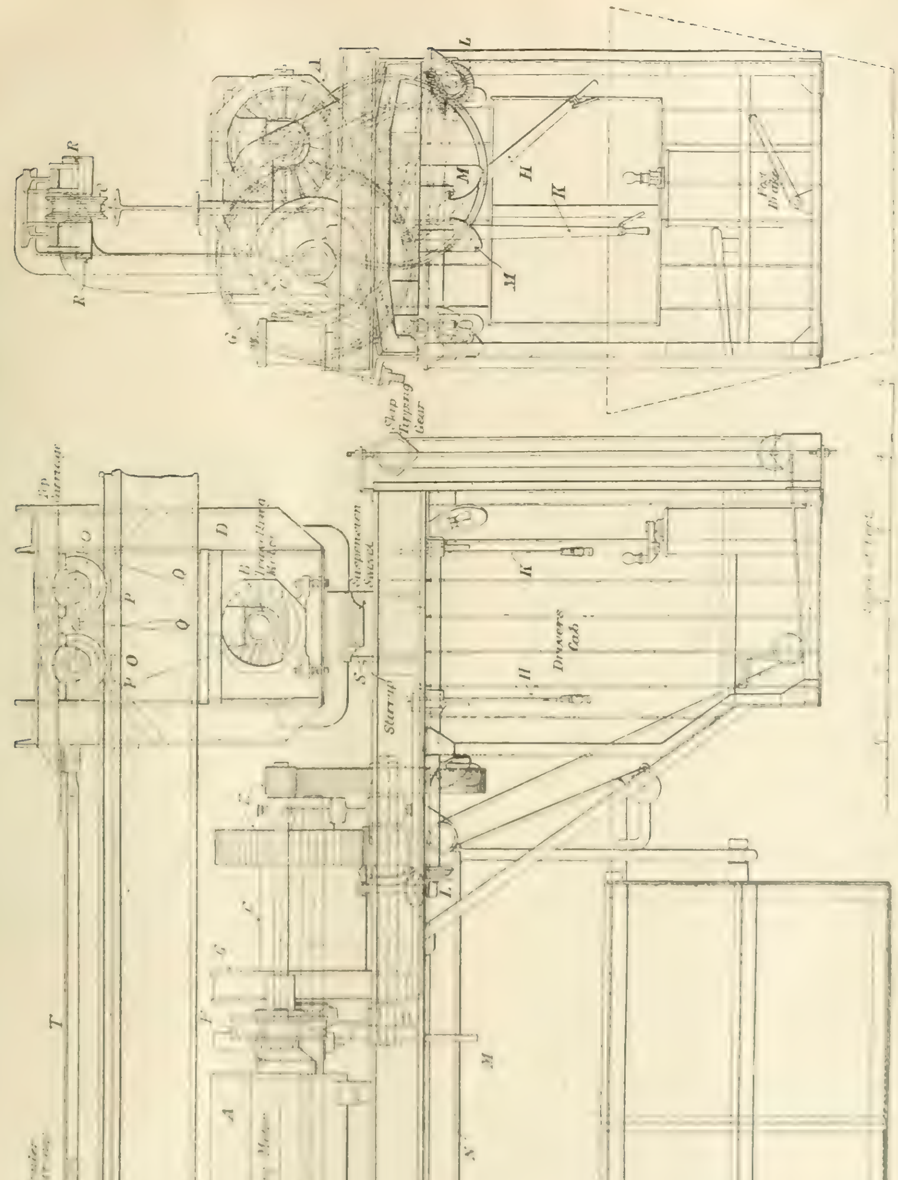


FIG. 3.—DEMPSTER'S "SPRING-WEB" SWITCH WHEN NEGOTIATING MAIN TRACK.

raises a horizontal roller to a position in which it engages a curved rib on the underside of the central switch tongue and swivels the leading bogie, thereby diverting it to the spur track. The trailing bogie follows the leading one by a positive means, which is not dependent upon the operator. No steering is necessary when returning from the spur to the main track or when running through a switch on the main track in either direction. He says that the arrangement eliminates all danger of running out of an open switch, and that it also saves time, since the operator does not have to stop and change the switch ahead of him.

* See "Engineering Magazine," May, 1916.


Drivers Cab
Stirrup
Suspension Swivel
Slip Tripping Gear
Foot Brake
T
A
M
M
K
H
L
D
P
O

The telpher machine to be chosen should have the smallest possible wheel base when curves have to be negotiated. The switches should preferably be so arranged that the man can operate them from his cab, and the live cables should be so placed that the current is automatically cut off when the track is open in order to bring the telpher to a standstill when approaching such an open track. As an additional safeguard a mechanical stop should be provided which would arrest the telpher machine if its inertia should carry it forward on the track, even with the current off. The disconnection of this current should bring an automatic brake into action which will stop the progress of the telpher almost instantly.

The writer, in his capacity as consultant for handling schemes, has had a unique experience in inspecting all systems of telphers, not only at the spot where they are "doing their bit" in our industries, but also (by the courtesy of the manufacturers) in their cradles, so to speak, and he can say without fear of contradiction that there is not a telpher machine made nowadays in this country which is unserviceable. Most manufacturers have a certain class of industry for which they particularly cater, and for which their plant may be more useful than that of any other firm, but beyond this reservation there is not much to choose between them.

Generally speaking the mono-rail telpher is, in the writer's opinion, more suitable for net loads of over 1 ton, while the bottom-flange telpher is more applicable to loads not exceeding 1 ton.

Some Examples of Telphers.

In its essentials the telpher machine consists of a structural steel frame composed of channels and plates supported generally from two trollies or bogies, one of which is geared to the travelling motor whilst the other one acts as a trailer; for extra heavy work and steep gradients both may be motor driven. If the telpher is fitted with hoisting gear a second motor with its hoisting drum is also within the frame, together with its first and second motion gears, clutches, brakes and controllers. While the travelling motor is generally geared by chain to the trolley wheels, the hoisting motor is more positively geared to the hoisting drum by cut gear-wheels. No chains should be used for the hoisting gear, as, in the event of such a chain breaking, the load would be dropped, while if the chain of the travelling motor were to break nothing worse could happen than the bringing of the machine to a standstill.

The travelling wheels are either of manganese steel, of high-carbon cast-steel, or of car-wheel iron, with chilled tread and flanges. Brakes are applied to some or all of the trolley wheels, generally electrically operated and applied to the armature shaft of the driving motor, and so arranged as to act with full force whenever the current of the trolley motor is interrupted. A foot brake may also be used instead of, or in addition to, such electrical brakes. Provision should be made for two brakes for the hoisting gear, one mechanically operated and the other electrically, either of which should be capable of holding the load in suspension at any point. The electrical brake should act on the motor spindle and be arranged to act with full force the moment the hoisting current is interrupted. It is preferable that the hoist be provided with an automatic limit switch connected in series with a hoist-motor, which automatically prevents over-winding; this switch is operated automatically by the ascending load. The lowering of the load may be effected on the hand brake. There should be a safety interlocking device between the gear release and the brake for the purpose of rendering any disconnection between the hoisting barrel and motor impossible until the operator has taken full control of the load by the hand brake. With such a hand brake the lowering of the load can be very quickly effected by an experienced man, but there is the danger of dropping it too fast, and in order to make the part of the [illegible] fool proof some makers fit an automatic brake on the drum spindle which limits the speed of the descent.

When curves have to be negotiated the bogies must be swivelled in order to [illegible] themselves more easily to the track, and these swivels should be so arranged that the load rests on ball-bearing supports, the swivelling pin not bearing any weight.

The most suitable current for a telpher installation is direct current, as it simplifies the arrangement of the live rails or conductors. Alternating current, particularly if three-phase, requires a very complex wiring. Controllers must be provided for each motor of a type similar to that used in tramways in order to allow of a wide range of speed. Current is collected from the live rails by either a shoe-type collector, or the more common trolley wheel type. In the latter case figure 8-section copper wire is used for conducting current. When the shoe-type collector is used the conductor often takes the more rigid form of a T or L section.

A few types of telpher machines, as built by the principal makers, are illustrated and briefly described in the following:—

Figs. 4 & 5 represent side and end views of the standard telpher machine as built by Messrs. Strachan & Henshaw, of Bristol.* The two motors are of the British Thomson-Houston make. A is the hoisting motor of 35 H.P., lifting $4\frac{1}{2}$ tons at the rate of 90 ft. per minute; and B the travelling motor of 8 H.P. The latter is carried on the main frame between the two hoisting barrels C, while the travelling motor is supported

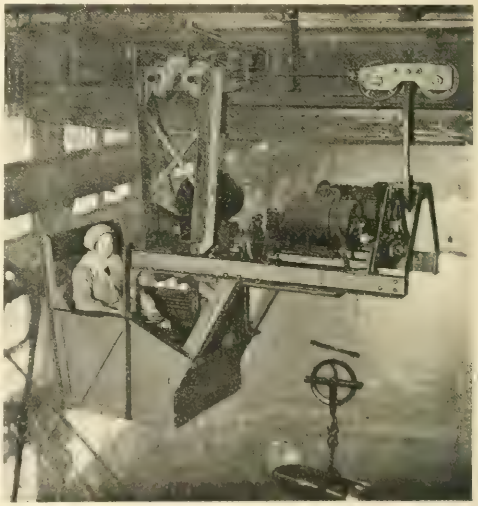


Fig. 5.—Photographic View of Telpher, by Messrs. Strachan & Henshaw Ltd.

on the adjustable feet in the driving carriage D. The lifting motor is coupled to the hoisting barrel through double reduction, machine-cut spur-gears E. The spur wheels are of cast steel, cut from solid rims, while the pinions are cut from mild steel bars and case-hardened. There are two hoists brakes, namely F, the automatic series solenoid brake which is automatically and instantaneously applied the moment the current is cut off from the hoist motor, and the free barrel brake G, controlled by the hand lever H, which also actuates a safety interlocking device between the gear release and the brake. The purpose of this interlocking gear is to render any disconnection between barrels, gear and motor, impossible until the operator has taken full control of the load by the hand brake. The hoisting gear may now be released by the handle K and bevel gear L, and the load lowered by gravity under hand control. MM are safety hooks to give an additional support to the load when travelling as they engage automatically with bale N. The travelling wheels O are driven by the gear wheels P, and the two roller chains Q. The travelling wheels are of manganese steel and keyed upon hardened steel axles which are housed in roller bearings R of

* From "Engineering," Feb. 16, 1917.

ample proportions. The two bogies are pivoted to the main frame by the anti-friction swivels S and S_1 and are coupled above the track by the bar T.

The illustration, Fig. 5, is a photographic view of a 10 cwt. telpher of the same engineers, quite a number of which are now at work in munition and other machine shops, where they render good service. The line drawing, Fig. 6, represents the same machine, which is operated by two Westinghouse motors of $1\frac{3}{4}$ H.P. each, one for hoisting and the other for travelling. These machines are capable of travelling at a speed of about 400 ft. per minute. An electrical overwinding switch automatically throws the hoisting motor out at the top of the lift, while an automatic magnet brake arrests the load immediately the current is cut off. The brake is of substantial construction and suitable for lowering the load by gravity under hand control. The wheel trucks are of a free swivelling bogie type, as are all Strachan & Henshaw's machines, and are so mounted that sharp curves can be negotiated with ease, even under the maximum load. All the electrical equipment used in these particular machines are of the British Westinghouse Co.'s manufacture. The illustration shows a machine with an open

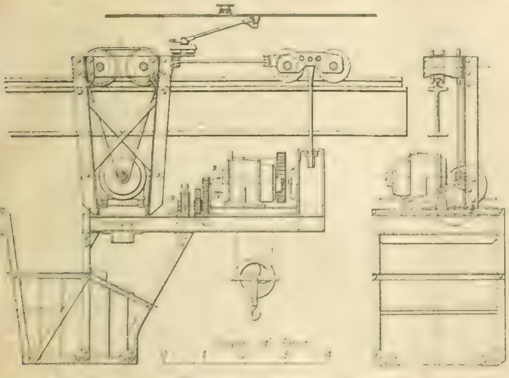


FIG. 6.—10 CWT. TELPHER MACHINE OF MESSRS. STRACHAN & HENSHAW, LTD.

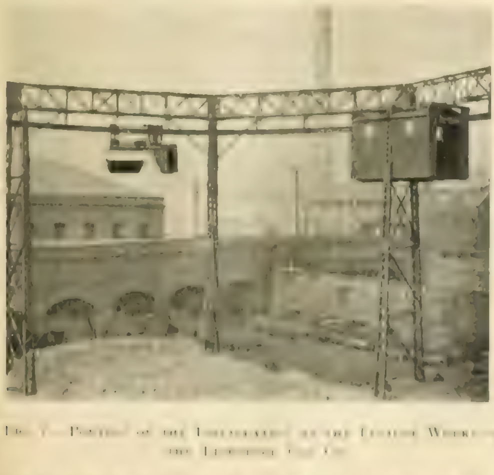


FIG. 7.—PORTION OF THE [illegible] AT THE [illegible] WORKS OF THE LIVERPOOL GAS CO.

cab for indoor work, or [illegible] totally enclosed. They are easily manipulated by [illegible]. The photographic view, Fig. 7, represents a portion of a telpher track and machine at the Linacre Works of the Liverpool Gas Co. by Strachan and Henshaw, which is [illegible] above the ground, and the same firm have built installations [illegible] up to [illegible].

The line drawing, Fig. 8, shows one of the mono-rail telphers of Messrs. Jenkins & Co., Ltd., of Retford, with a Priestman grab, as supplied to the Hackney Power-Station. The machine has been designed after careful observation of all details and is most efficient and durable, being remarkable for its unusually silent running. The extensive works of Messrs. Jenkins have been visited by the writer, where he has seen [illegible] installations in course of construction, including the [illegible] of the steel structural work, rail-track and trestles in addition to the telpher machines themselves.

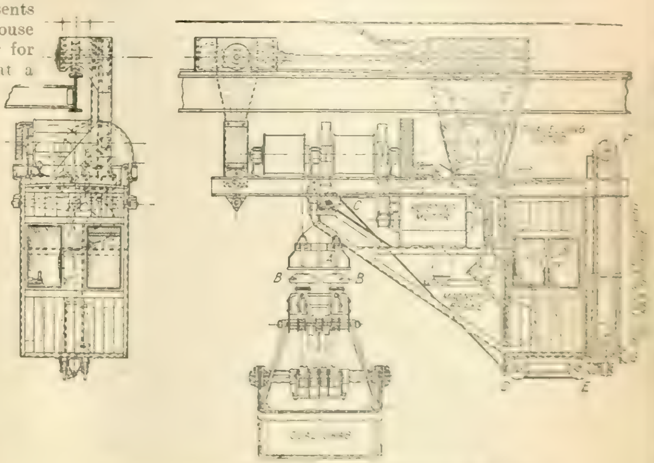


FIG. 8.—MONO-RAIL TELPHER BY MESSRS. JENKINS & CO., LTD., FITTED WITH PRIESTMAN GRAB.

An interesting installation is that erected by the same engineers for the Adelaide Gas Works, Australia, for the primary object of dealing with the whole of the hot coke from the retorts. The photographic view illustrated in Fig. 9 shows a portion of this installation, including the [illegible] bunkers with the automatic [illegible] and a portion of the telpher track with a machine [illegible]. The [illegible] coke is handled by the telpher [illegible]

FIG. 9.—TELPHER PLANT [illegible] ERECTED AT THE ADELAIDE GAS WORKS, AUSTRALIA.

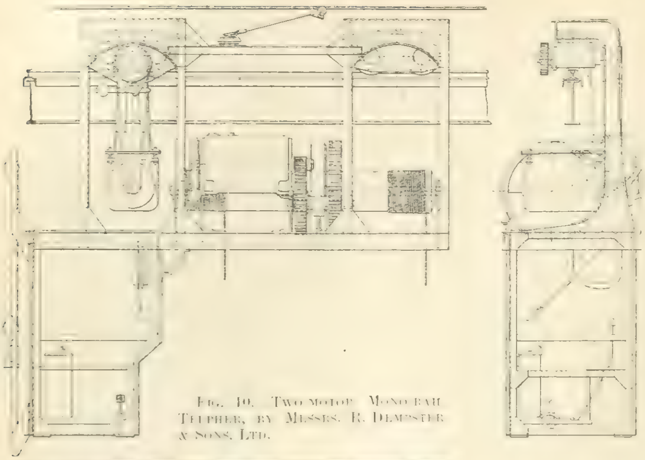


Fig. 10. Two-motor Mono-rail Telpher, by Messrs. R. Dempster & Sons, Ltd.

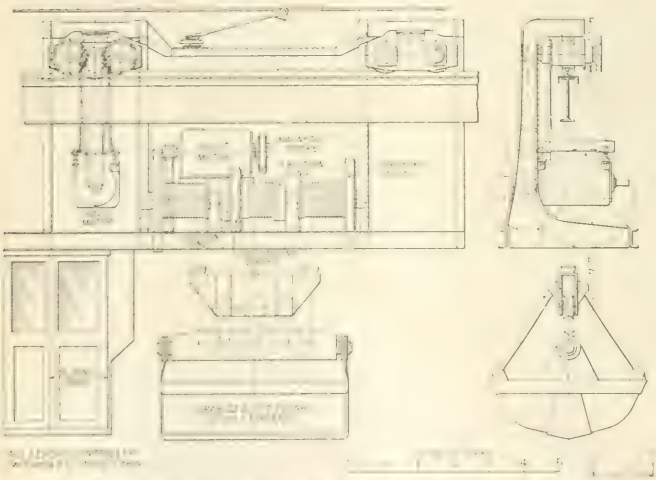


Fig. 11. Telpher fitted with 3-rope Grab, at the Electricity Works, Battersea, erected by Messrs. Dempster & Sons, Ltd.

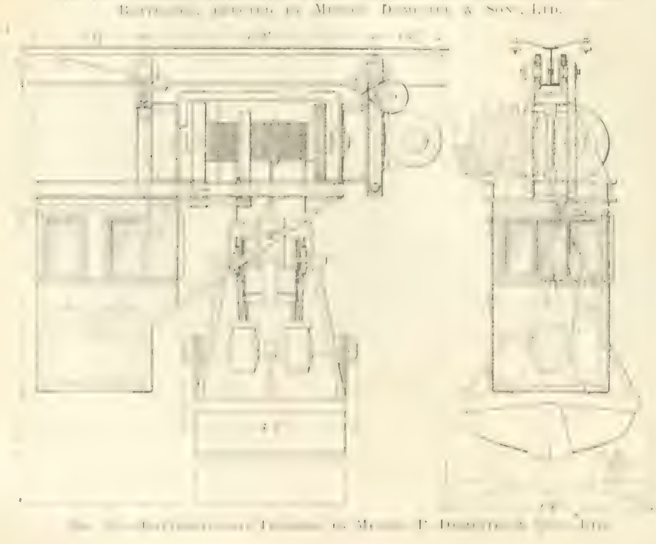


Fig. 12.—Bottom-flange Telpher by Messrs. R. Dempster & Sons, Ltd.

into a water tank and then gently deposited by the skip into one of the four bunkers or dumped at any part of the yard traversed by the telpher track. The total length of the telpher track is 246 ft. and is 40 ft. above the ground. Frequently the hot coke is partly handled by the De Brouwer hot coke conveyer and partly by the telpher, which makes a good division of labour; the process is, moreover, more continuous but also somewhat more costly, the advantage being that with such a combination the telpher machine need not be exposed to the intense heat of the incandescent coke, an exposure which the hot coke conveyer can stand without a relatively great depreciation, when considering that hot coke is one of the most trying and costly materials to handle.

The next illustration (namely, line drawing Fig. 10) shows a two-motor mono-rail machine of Messrs. Dempster & Sons, the rigid steel frame and hangers are of pressed steel of pleasing form, the swivel bogies are self-aligning and the whole machine is of very simple design. Line drawing Fig. 11 shows a similar machine of the same makers fitted with a triple rope grab. The latter illustration is a drawing of the machine used in the installation shown in Fig. 13. The diagram, Fig. 12, represents a specimen of the bottom-flange telpher of the same manufacturer.

An interesting telpher installation is shown in Fig. 13. It has been erected by Messrs. Dempster & Sons for the Electricity Works at Battersea, and is designed for dealing with coal from barges at the rate of 40 tons per hour; the lifting speed is 85 ft. per minute and that of travelling 500 ft. This telpher is fitted with a three-rope Priestman grab (also indicated in Fig. 11), which can be discharged at any required height by a patent device embodied in the hoisting mechanism (Hargreaves Dempster); the central discharging rope is carried on a special barrel of the same diameter as the hoisting barrel, but provided with a friction device and independent brake. The action is as follows: immediately the grab is lifted to the predetermined height the brake is applied automatically and the discharge of the grab can then be affected by paying out the hoisting rope. The total length of the track of this installation is 250 ft. and the height of the mono-rail track above the ground is 85 ft. A feature of additional interest in connection with this installation is an arrangement by which the passing loads can be weighed while in motion by a "non-stop" type of weighing machine which records and totalises the weight of the coal handled without having to stop the telpher machine for the purpose, which has hitherto been the more usual process.

The telpher installation at the Nechells Gas Works, Birmingham, erected by Dempsters, is shown in the photographic view, Fig. 14. In this installation the coke is delivered from the gas retorts by hot coke conveyer and discharged into a ferro-concrete bunker. From the bunker it is delivered by shoot and a patent filling device into the telpher skip; this device is quite automatic and controlled by the operator from the

telpher cabin. Two machines are running on this track, which is 950 ft. long and about 55 ft. above the ground; these machines carry coke from the bunker to the screening plant as required. The hoisting speed of these telphers is 75 ft. per minute and that of travelling 450 ft. to 500 ft.

A very compact little telpher is that of Dempster's, designated by the makers as a "two motor electric trolley hoist"; this type of machine being open is particularly suitable for inter-departmental traffic; the design is very neat, compact and easily accessible. These machines are built in three sizes,

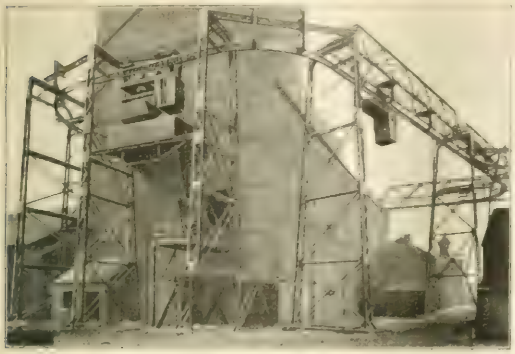


FIG. 13.—TELPHER INSTALLATION AT THE BATTERSEA ELECTRICITY WORKS.

namely, for 1, 2 and 3 ton net loads; being a bottom-flange telpher the smaller size for 1 ton appeals most to the writer. The hoisting speed is 35 ft. and the travelling speed 350 ft. to 400 ft. per minute.

A transporter, built by Wm. Wadsworth & Sons, of Bolton, is shown at work in the photograph (see Fig. 14). This machine is different from those previously described in so far as the motor and winch are stationary, while the load is transported and hoisted by a cable and trolley or running head. The machine as illustrated is built for loads of 15 cwt.; it hoists at a speed of 140 ft. per minute, and the horizontal travel is 200 ft. per minute, the motor being one of 15 H.P. running at a speed of 1,100 revs. per min. These achievements are rather above the average and hence the greater horse-power required, the average speed for this kind of transporter being 60 ft. for hoisting and 80 ft. to 100 ft. for travelling per minute.

FIG. 14.—TRANSPORTER, CONSTRUCTED BY MESSRS. WM. WADSWORTH & SONS, OF BOLTON.

There is, of course, no reason why these transporters should not run faster, but as a rule the total length of the track is not great, which is not in favour of high speeds; otherwise there is no reason why a travelling speed of 500 ft., like that of ordinary telphers, could not be attained.

FIG. 15.—TELPHER INSTALLATION AT THE [illegible] GAS WORKS, MANCHESTER.

Frequently the tracks of transporters are only about 90 ft. long, so that a speed of 80 ft. or 100 ft. is then the most favourable. It will be apparent that the power required by machines of this type is governed directly by the load and speed of lifting; for instance, if the 15-cwt. transporter in question hoists at a speed of 60 ft. per minute it will require

a 6 H.P. motor, at 90 ft. a 9 H.P., and at 120 ft. per minute a 12 H.P. motor. A 10 cwt. machine similarly required for lifting speeds of 60 ft., 90 ft. and 120 ft. per minute respectively, motors of 4 H.P., 6 H.P. and 8 H.P. These transporters are very economical in the consumption of current, and are rapidly gaining favour with industrials in all manner of trades, particularly for the warehousing and loading of goods. The motor takes practically no current when travelling or lowering, or when running the armature [illegible] putting on or taking off the load, the consumption of current being only appreciable during the actual hoisting operation, and this adjusts itself to the load lifted.

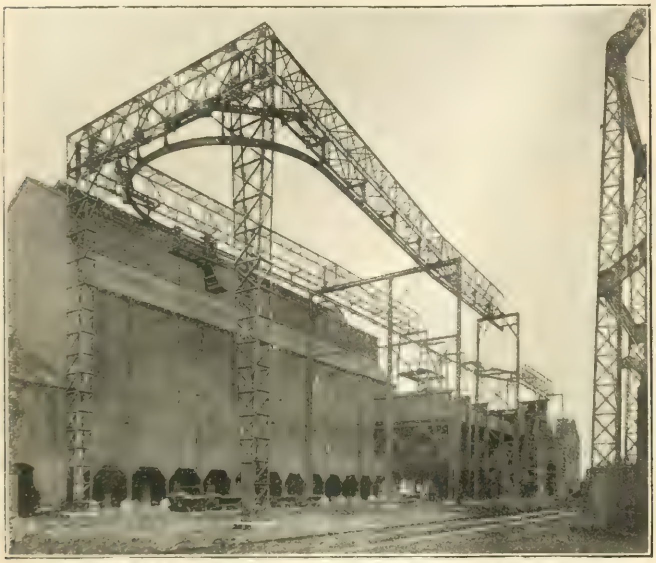


Fig. 16.—Telpher Installation at the Cardiff Gas Works, by Messrs. Strachan & Henshaw Ltd.

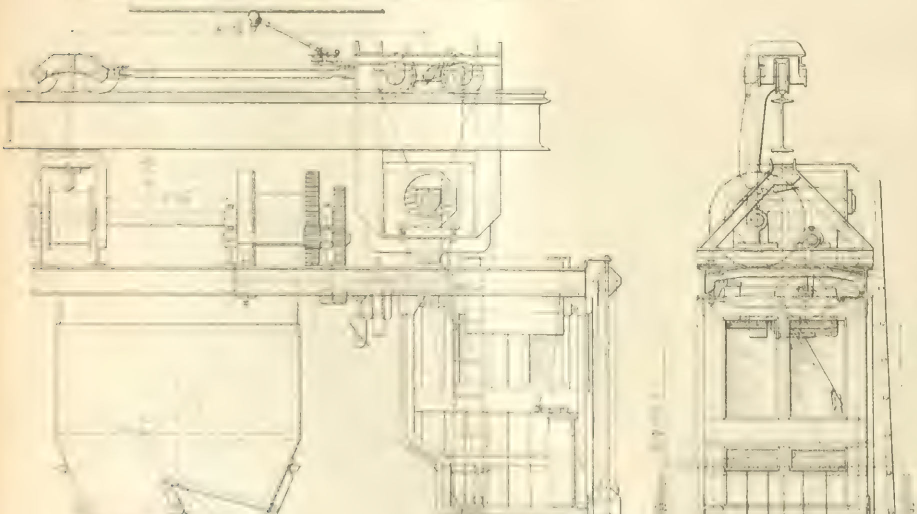


Fig. 17.—[illegible] by Messrs. Strachan & Henshaw, Ltd.

The two following telpher plants give a little insight into the saving in labour which can be effected. At the Ford Plant, at Detroit, 10 mono-rail telpher machines are employed along the main aisle of the shop and through the yards, the total length of the track being $1\frac{1}{4}$ miles. There are 21 switches which render the system extremely flexible; most of these are operated by the driver from his cab, but at the points of junction, where the traffic is extra heavy, switchmen are stationed. Each telpher machine is capable of carrying a net load of 2 tons at a speed of 10 miles per hour, and a 40 H.P. generator is used to furnish the current for the system. All the material used in these huge works is carried to the storeroom and again from there to the shops by the telphers; all the scrap metal, to the amount of 70 tons per day, is likewise disposed of in the same manner. Mono-rail telphers have here been found particularly useful in the foundry for handling pig-iron as well as finished castings, and whereas three men can manually handle only 2 tons per hour, or 18 tons per day, with trucks, a mono-rail hoisting telpher can handle 72 tons in 9 hours, making two round trips, while the men are making one. The machine is, therefore, doing twice the amount of work with one man in charge in half the time it takes three men to accomplish it.

In a large telpher installation of the Hood Rubber Co., at East Watertown, Mass., erected by Westinghouse, Church, Kerr & Co., 67 per cent. of the cost of the former handling by cart and hand trucks has been saved. The installation operates on the bottom flange of a standard I-girder, and the machines handle net loads of $2\frac{1}{2}$ tons. The lifting speed is 50 ft. per minute at full load and 100 ft. per minute with no load; the travelling speed with full load is 350 ft. per minute and 400 ft. per minute with no load. Direct-current at 220 volts is employed. This equipment paid for itself on a 67 per cent. basis in $2\frac{1}{2}$ years from the date of installation.

The true aspect of the more or less progressive movement in the adoption of labour-aiding machinery is well expressed in a humourous vein in the following words by Mr. Charles M. Horton, in "Industrial Management," August, 1917: "The fundamental place that labour-saving machinery occupies in the world's scheme of things has never been fully set forth. Men in all walks of industrial activity, from labourers to capitalists, and from capitalist to economist, have argued it pro and con, and continue to argue it pro and con., and still the automatic machine comes skidding into the affairs of men, and still the men of labour protest, and still the men of capital fur, and still the economists explain and gesticulate and froth at the mouth, and still the old earth 'she moves.'"

The Automatic Disposal of Ashes from Power Houses by Means of Ropeways.

By J. WALWYN WHITE.

Summary.—Although the immediate removal of ashes from the power house can be secured by various means, such as [illegible], telphers, suction plant, &c., the range of action of such devices is comparatively limited. If transport is desired [illegible], then the problem is most easily solved by means of the ropeway. Such plant is efficient and costs but little [illegible]. [illegible] of ropeway installations are described, specially adapted for this purpose.

ONE of the many problems, and by no means the least important, that the electrical power station engineer has to solve is the disposal of the waste ashes from his boiler house, with the least possible expenditure of money and man power.

The latter phase of the question becomes more and more acute as time goes on. The proposition usually divides itself into two parts. Firstly, the collection of ashes from the boilers themselves, and, secondly, the final disposal of the ashes when collected from the boiler house, for it is not sufficient in these days of high wages and shortness of labour, merely to collect the ashes and tip them into the railway wagon or road cart for final disposal, as it is very seldom that the station engineer is fortunate enough to find sufficient tipping ground for his debris close to his power house.

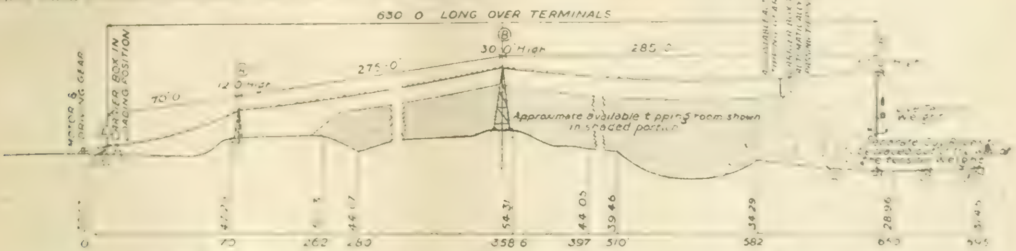


Fig. 1.—General Elevation of an Aerial Wire Ropeway for Automatic Ash Disposal.

Fig. 2.—[illegible]

I do not propose to deal with the first part of this problem or to enter into the merits of the various methods now employed for collecting the ashes from the boilers, such as:—

(a) Tramways, with tipping wagons.
(b) Conveyors, whether of the scraper, belt or other types.
(c) Gravity bucket conveyors.
(d) Overhead runways.
(e) Telfer lines.
(f) Vacuum pipe conveyors.
(g) Hydraulic conveyors.

Speaking generally, the range of [illegible] of these conveyors is limited, and cannot be said to be suitable for long-distance conveyance, such as is usually necessary for the final deposition of the ashes.

It will be sufficient to assume that the ashes have been collected by one or other of the methods named to one central point, and that it is required to economically deliver them to their final destination on waste land, or disused quarry, some distance away. And here it is that the modern aerial wire ropeway conveyor efficiently solves the second part of the problem in most cases. [illegible]

Aerial wire ropeways are [illegible] moving rope system, and [illegible] of ropeway, though very simple in design and working, is not generally the best type for our purpose.

It is essential for cheap working that the [illegible] should be automatically tipped on the dumping ground, and the empty carrier should automatically return on to the return rope without handling in any way. The [illegible]

[illegible] readily respond to these conditions, and, what is [illegible] the case of a breakage of the rope the whole thing, rope and carriers, whether loaded or empty, come to the ground, involving complete stoppage of the plant, and many [illegible] work to get them reinstated and working again. And this is the last thing the station engineer wants.

FIG. 3.—SHOWING THE CARRIER BUCKET IN THE ACT OF AUTOMATICALLY TIPPING ITS LOAD.

It is therefore, to the bi-cable, or double rope system, that we must look to fulfil amply our conditions, and modern installations after many years of continuous working prove our confidence in this type of conveyor to be well placed.

In this system the loaded carriers travel along a fixed rope or ropes, by means of travelling supporting sheaves, that run on the rope itself, a separate and lighter rope being used to haul the carriers from one end of the line to the other, around the return terminal, and back again to the loading point, the loads being tipped anywhere along the route entirely automatically, so that, as a matter of fact, the carriers are never touched by hand, from the time they leave the loading berth until they arrive back again empty and are automatically detached from the hauling rope and stand ready for loading again. All this is secured, even if the line be several miles in length, with various angles en route, either vertical or horizontal. By this system much heavier ropes can be employed to carry the loads than is practicable with the [illegible] already [illegible], so that the danger of a rope breaking is much less, and [illegible] almost unknown, whilst even if the main standing rope did break, the hauling rope is [illegible] enough to keep the carriers from falling to the ground [illegible] of the line is affected [illegible] can be further localised by using the sectional system in which a [illegible]

[illegible]

connecting and disconnecting automatically with the carriers, and some of them capable of taking heavy loads up gradients as steep as 1 in 2 without slip and under all conditions of weather.

One of the greatest improvements in this type of ropeway is the adoption of the locked coil system of ropes as the main carrying ropes. A good locked coil rope has a hard, smooth surface with a coefficient of rolling friction little, if any, greater than that of a steel rail, whilst the close interlocking of its outer layers keeps the weather out and the internal lubrication in, effectually preventing corrosion of the inner wires.

Bi-cable ropeways are divided roughly into two types. The first and simpler consists of a single standing rope along which a single carrier travels, being traversed backwards and forwards by an endless haulage rope, the travel of which is automatically reversed as the carrier reaches one or other end of the line. The carrying capacity of this form of ropeway is naturally limited, owing to only one carrier being used.

When the line is of any length, the ordinary double ropeway is used, having separate outwards and return carrying ropes, with the hauling rope constantly running in one direction, outwards and homewards, with a constant succession of loaded carriers on the outward rope and empty carriers on the return rope, as already described.

Such lines have been constructed with a length of 20 miles and more, and with carrying capacities of up to 300 tons per hour, but such installations do not come within the scope of the present article, the requirements of the station engineer being usually much more modest, both as to length and carrying capacity.

Fig. 1 shows the lay-out of a single-track bi-cable ropeway erected at a power station for taking away ashes from the boilers and clinkers from the destructor furnaces in connection with the steam plant. The driving and loading terminal shown in Fig. 2 are situated close to the boiler house, and the ashes and clinkers are wheeled out in hand barrows and tipped into the ropeway carrier box, shown in the illustration. In

FIG. 4.—COAL CONVEYOR FOR AUTOMATICALLY DEPOSITING COAL ON THE STOCKING GROUND.

most cases, however, the terminal of the ropeway is continued on by means of a fixed runway, so that the carriers can be run by hand directly in front of the furnace doors and the ashes raked directly into the carrier boxes.

As soon as the carrier is loaded the operator moves a switch and the loaded carrier travels outwards, to the place where the contents have to be tipped. At this point a tipping frame, which may be varied in position, is suspended on the main carrying rope, and when the carrier reaches this frame a projecting bar catches the safety trigger on the carrier box, and the load automatically empties, as shown in Fig. 3.

At the same time the automatic reversing gear on the driving

wheel is reversed, and the carrier, after tipping its load, commences its return journey, and automatically stops on arrival at the loading point, and stands ready to load again. The whole operation is exceedingly simple and self-acting, as the carrier, when once loaded, is not touched by hand from the [illegible]

point, and at the same time the [illegible] is altered to allow for the extended travel of the loaded carrier. In this particular case the carrying rope is [illegible] above the ground level, providing a tipping [illegible] and when this length of heap is completed the [illegible]

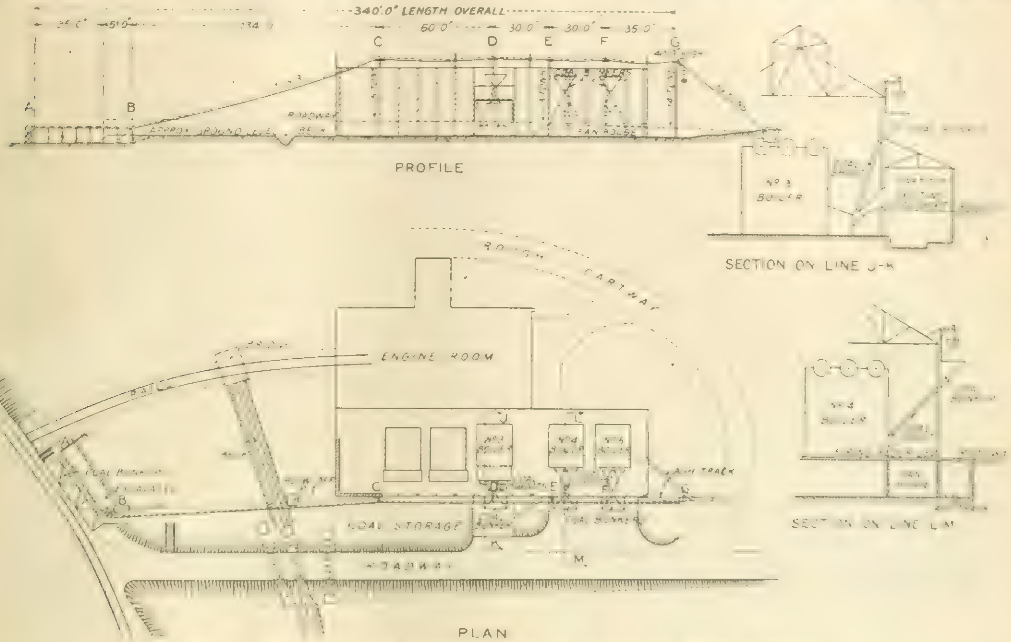
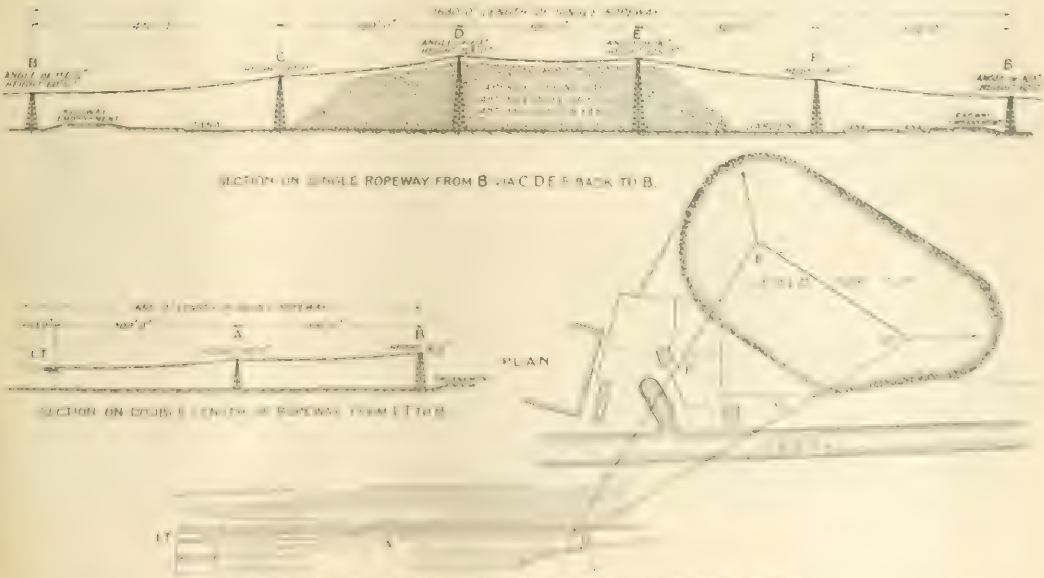


Fig. [illegible]—Arrangement for Depositing Coal into Overhead Storage Bunkers.



[illegible]

[illegible]

A modification of this type of ropeway has been erected at another power station for automatically stocking coal and for bringing it back again to the boiler bunkers when required. Fig. 4 shows part of the stocking ground before tipping commenced with a loaded carrier box on its outward journey. This carrier box, which holds a load of 1 ton of coal, travels on the main carrying rope as before, and as it was desirable that the coal should not be broken unnecessarily in tipping, a special box was designed with bottom doors to let the coal out gradually. In order that the coal when discharged from the box should have as little fall as possible, the cross-head and bracket supporting the carrying rope are mounted on the standards, so that they can be raised as the height of the heap of coal increases, as shown in the photograph. Conversely, when it is desired to take the coal away from stock, the carrying rope is lowered as the height of the heap diminishes to facilitate the loading of the carrier box, which can be done both by hand loading and also by a grab operated by an electric [illegible] running on rails temporarily laid all over the stocking ground before tipping commenced.

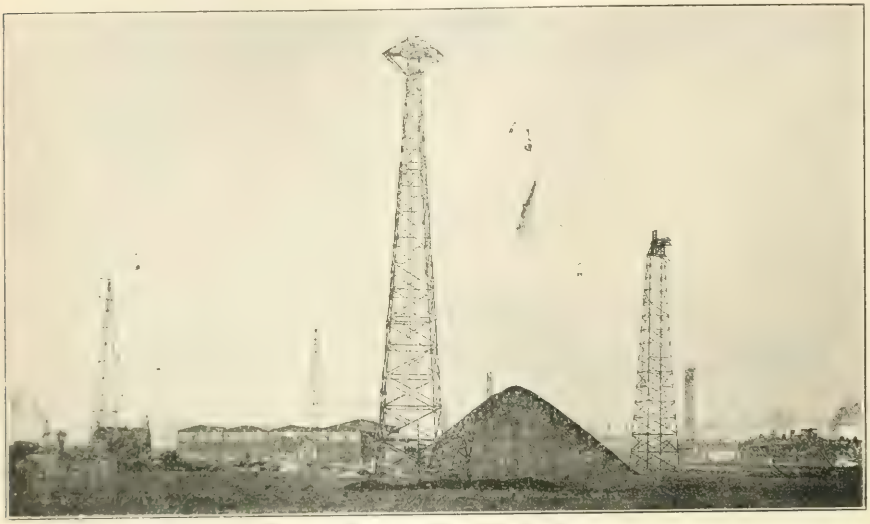


Fig. 7.—Circular-type Ropeway Conveyor, Covering the Whole of Available Tipping Ground.

Fig. 8.—[illegible] Heap.

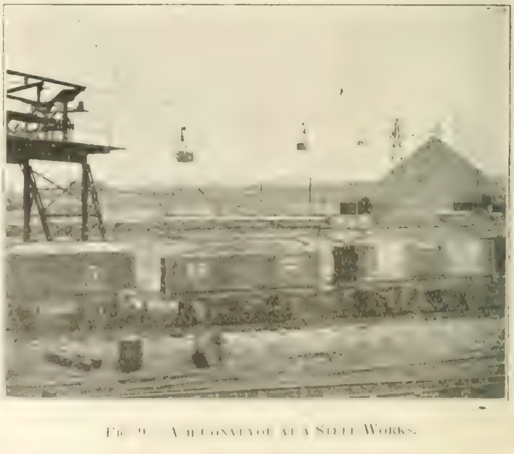


Fig. 9.—A[illegible] Conveyor at a Steel Works.

Another interesting form of this single rope bi-cable system has been adopted by a power station for conveying coal from railway wagons, with automatic discharge into the overhead coal hoppers, so as to lead the coal by means of shoots directly to the various boilers.

Fig. 5 shows a plan and profile of this ropeway, which is 340 ft. long over all. The coal in this case is discharged into suitable bunkers placed alongside the railway, as shown in this illustration, and it is then loaded by gravity into the ropeway box at any point on the fixed loading rail between A and B. Directly the box has been loaded the man in charge touches a switch, and the load is sent off on its forward journey.

The ropeway in this case is supported by brackets fixed to the upright columns alongside the power house building, as indicated on the drawing, and there is a gradient against the load of 1 in 3 from B to C. The coal is discharged automatically into any of the three overhead hoppers near points D, E and F, and in addition arrangements are made for discharging the coal automatically on the storage ground between C and D.

This plant is made with a capacity of 8 tons per hour with about 15 cwt. net loads, conveyed each time, in the carrier box. After the carrier box has been automatically discharged at any pre-determined point, as named above, it is automatically reversed, and conveyed back empty to the loading point directly in front of any of the three loading shoots of the loading hopper at the railway end, ready for loading again. A live weight tension arrangement for the hauling rope is provided at the return mast G, to maintain a proper and even tension.

The ropeway is rather a unique plant, inasmuch as it takes the place of the customary elevators or ordinary conveyors usually employed at most power stations, for taking the coal.

into the overhead hoppers, and it would seem that this ropeway is the means of saving a lot of intermittent work, as it conveys the coal directly from the railway wagons to the various boilers, as well as to the stocking ground when required.

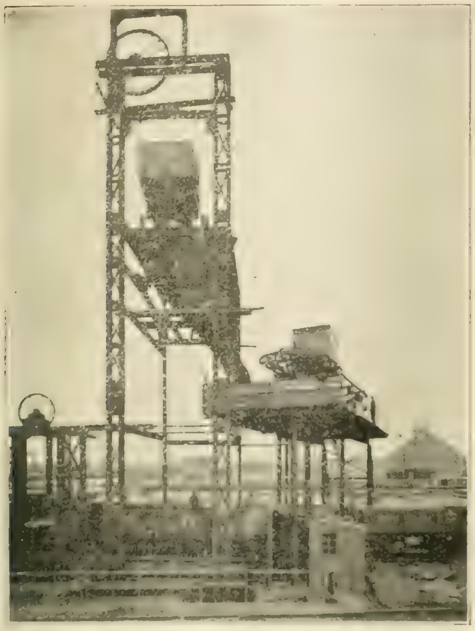


FIG. 10.—ELECTRIC HOIST, SHOWING THE HOIST BOX AUTOMATICALLY TIPPING ITS CONTENTS INTO THE HOPPER.

Fig. 6 shows a plan of an interesting arrangement of tipping where the ground space is valuable and where it is desired to make the best possible use of the land. As will be seen from this plan there is a kind of circular route of the tipping ground. Fig. 7 shows a photograph of the standards and automatic

FIG. 11.—GENERAL LAY-OUT OF LOADING TERMINAL OF RAILWAY [illegible], SHOWING ELECTRIC HOIST, STORAGE HOPPERS FOR ASHES AND LOADING GEAR OF ROPEWAY.

angle stations provided on this tipping ground, together with a ropeway carrier box in the act of automatically discharging its contents. The standards and angle stations in this case are 125 ft. high, giving an approximate tipping height in the centre of each span of about 105 ft., thus providing for an enormous capacity of tipping, with very limited ground area.

Fig. 8 shows an interesting ash tipping installation, indicating the original tipping height available with the standard very nearly buried in debris. Since this photograph was taken, however, a "dummy" standard 45 ft. high has been placed directly on the top of the debris close to the original standard, so as to make a total height above the loading station of about 120 ft., with a gradient of about 1·6 against the load at the point where the loaded carrier approaches the top of the standard. It is interesting to note that this ropeway is working exceedingly well, even with this very steep gradient.

I also wish to mention an important and interesting plant recently erected for taking away ashes from producer generators at a steel works, with automatic discharging on the tipping ground. This ropeway is about 1,400 ft. long overall, and capable of carrying 30 tons per hour in 10 cwt. net loads, but this capacity can be easily increased by simply adding on an extra number of carriers and boxes when required.

FIG. 12.—ASHES HOIST, SHOWING A LOADED HOIST BOX [illegible].

Fig. 9 shows a general view of the whole line, taken from the front of the loading station up to the automatic return terminal, which is some 750 ft. long. The intermediate standards graduating from 30 ft. high up to 125 ft. high, are erected as shown in the illustration.

The loaded carrier and boxes are tipped automatically at any point along the line and they are then conveyed round the return terminal automatically, without being detached from the hauling rope, involving no attention or labour. The loading terminal is placed on a steel structure, with a clear height of about 12 ft. above the ground level, so as to allow railway trucks to pass underneath, as shown in Fig. 11.

The ashes and clinker, &c., are brought up from the boiler [illegible] plants around the works by [illegible] railway wagons, which run over the top of an underground steel hopper of 1,000 cubic feet capacity, [illegible], at about 20 ft. below the ground level. Each loaded wagon is then discharged into the hopper by means of a hydraulic tipper. From this hopper

[illegible] hopper the ashes are loaded into a hoist box of about 3 tons net capacity, and then raised by means of an electric hoist shown in Fig. 10, right to the top, where the contents of the hoist box are automatically discharged into an overhead hopper of 600 cubic ft. capacity, after which the empty box is automatically lowered down to its loading position below the ground level for loading again. The total lift is about 75 ft.

This hoist is electrically driven, and forms a very simple and efficient means of conveying the ashes automatically into the overhead hopper, and its working is found to be more effic- ent than the more usual method of using ordinary bucket eleva tors for this purpose. From this hopper the material is loaded into the ropeway carrier boxes by gravity by means of an ordinary loading valve in the usual way.

After the ropeway carrier box has been loaded the man in charge simply gives it a slight push along the loading rail,

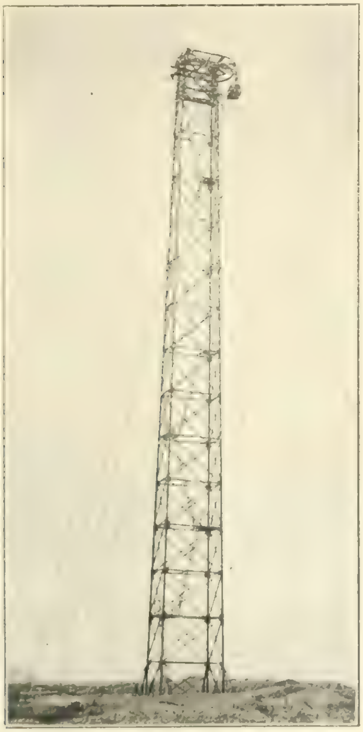


Fig. 13. Automatic Return Terminal of Ash Conveyor, 150 ft. high, showing Carrier in the act of [illegible] towards the Loading Terminal.

down a short incline, when each carrier is automatically attached to the carrying rope and does not require any further attention whatever until it comes back again and is automatically released from the hauling rope and stands ready for loading again.

The ropeway, which is electrically driven, is of the double rope system already described. The hauling rope is driven by a driving wheel, 6 ft. diameter, around which it makes [illegible] turns, and the driving gear consists of ordinary bevel gear, together with a special form of chain reduction gear for reducing the speed between the electric motor shaft and the horizontal driving shaft of the bevel gear. The chain reduction gear, although somewhat expensive in first cost, gives beautifully smooth and very [illegible] results, with a minimum of [illegible], as it is entirely enclosed in a [illegible] gear box, which is always kept partially filled with a suitable lubricant, so that the chains and chain wheels are always kept lubricated, and absolutely free from dirt and dust. This latter item is a very important consideration when working in ashes, as any station engineer will know.

Fig. 11 is a side view of the loading, driving and tension terminal, and shows a small sheet iron cover on the top of the terminal frame, for protecting the motor and the chain reduction gear, &c. This will give an idea of the very compact arrangement of the gear, &c. The tension in the hauling rope is constantly maintained by a live-tension weight suspended at the end of a rope at the front of the terminal, as shown.

Fig. 12 shows a near view of the lift box, as it is descending below the ground level in front of the underground hopper, whilst Fig. 13 gives a general view of the 150 ft. automatic return terminal, showing a carrier box in the act of rounding this terminal automatically. This illustration also shows a ladder arrangement, provided inside the steel frame, so as to give easy access to the top of the terminal. Fig. 14 gives a further view of the tipping standards, showing the carrier box in the act of automatically discharging its contents.

The tipping standards in this case have been made specially high, so as to provide for plenty of tipping room right from the outset, although when these standards have all been buried in debris it will be an easy matter to increase the tipping height still further by using the maker's special type of "dummy" standard, which can be placed directly on the top

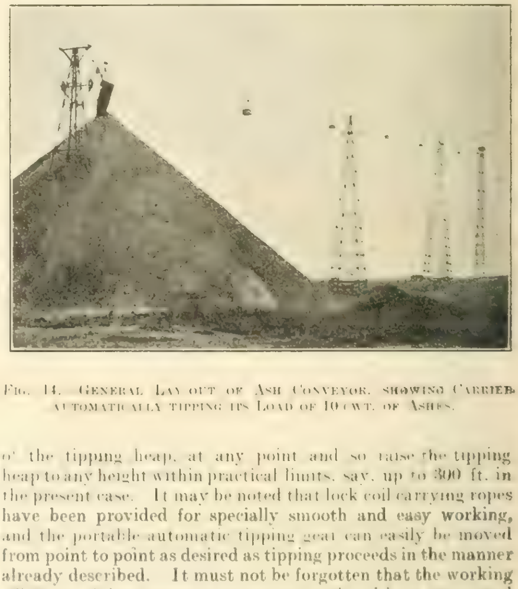


Fig. 14. General Lay-out of Ash Conveyor, showing Carrier automatically tipping its Load of 10 cwt. of Ashes.

of the tipping heap, at any point and so raise the tipping heap to any height within practical limits, say, up to 300 ft. in the present case. It may be noted that lock coil carrying ropes have been provided for specially smooth and easy working, and the portable automatic tipping gear can easily be moved from point to point as desired as tipping proceeds in the manner already described. It must not be forgotten that the working efficiency of these ropeway conveyors, such as I have attempted to describe, is very high, very little power is required to drive them, the working costs are very low, as one man only is required to look after them, and the wear and tear exceedingly small, in pleasant contrast to some other forms of conveyors.

The carrying wheels, hauling rope rollers and automatic return wheel are all provided with sufficient lubricant for one month's continuous run, so that the cost of supervision is very low, and if a few spares are kept in stock the stoppage of the plant in case of accident is limited at the most to a few hours' delay.

If hoppers are provided of sufficiently large capacity the whole of the day's accumulation of ashes can be run off and disposed of in two or three hours' working per day, instead of necessitating continuous working, such as is required with small capacity plants, thus leaving the one man free for other duties between the hours of running.

The Electric Vehicle For Handling Goods in the Works and on the Road.

By RAYMOND J. MITCHELL.

Summary.—After dealing briefly with the scope of the electric vehicle and the construction of the chassis, [illegible] use of such vehicles on the road. This form of service is now becoming well recognised. The utility of [illegible] well known, but from the point of view of the factory it is no less important.

NOW that over a thousand electric vehicles are in active use in this country, in almost every important trade, industry and national enterprise, it is finally admitted, even by its former detractors, that the battery vehicle has come to stay. From an attitude towards the industry which only a short while ago was one of unconcealed hostility, even the motor press now recants. It is now realised that this phoenix-like industry has passed through the fire of experience and emerged therefrom rejuvenated, and strong enough already to fight its battles single-handed; moreover, that the test of achievement will inevitably give to the accumulator vehicle a status in its own field with which there is little chance of competition, by either its petrol or steam-propelled rivals.

Not only the intrinsic merits of the electric vehicle but also the increasingly high price of petrol [illegible] obvious point to the sheer expedience and urgency of [illegible] an alternative to the petrol [illegible] by any reasonable means it can be employed. [illegible] is intended to prove there is no need [illegible] petrol for town [illegible]

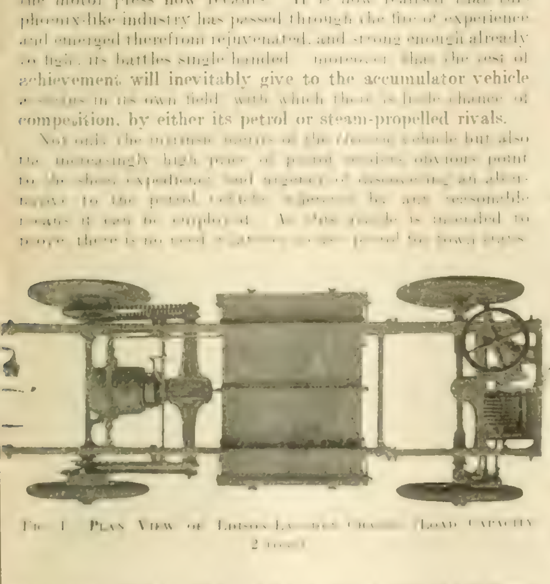


Fig. 1.—Plan View of [illegible] Chassis. (Load Capacity 2 tons.)

port; nor in fact would its total suppression cause the slightest inconvenience to that service once the existing fuel-consuming vehicles were replaced by the far more rational electrically propelled machine. Just as the electric will displace the horse and internal-combustion engine for urban transport, so will its use render far too expensive the present-day luxury of manual labour in many hundred large factories in this country. The electric truck—a sort of miniature road vehicle, designed for great mobility and low speed—is already causing a revolution in the handling of materials in practically every situation where its virtues have been put to severe practical tests. It does not yet seem to be sufficiently well appreciated that the most valuable part of a man is his brain, and that to use a man's muscle power for that which can be performed mechanically is both degrading to the man and enormously costly per unit of work done. Hence the desirability of examining the claims made for the electric vehicle and, if these be found to be justified, [illegible] that whenever a transport problem arises, the first query in the mind of the engineer shall be: "Can I do it electrically?" The answer to the query [illegible] any other means?"

The vast sums of [illegible] millions of [illegible] all the [illegible] In fact, in most cases, [illegible] rather on the conservative side. On the score of economy, simplicity, reliability, mobility, and safety, the electric vehicle has proved itself unrivalled in its own sphere, whilst there are many traction jobs which could not be performed efficiently without its aid. This is only to be expected of a system of road locomotion which is based on such exceedingly simple principles as those applying to all electric vehicles. It is, in fact, practically impossible for even the engineer of great imagination to divine any way by which a power vehicle could be further simplified in conception. It is probable—and certain that for the present—the accumulator vehicle is the finally simplified form of automotive vehicle.

The Scope of the Electric Vehicle.

The ideal conditions for operating [illegible] level smooth roads. Large [illegible] other cities in this country supply these conditions exactly. It is, however, true that nearly any town approaches these conditions sufficiently closely for good practical running results to be obtained from electric vehicles. The chief condition to be satisfied is that the vehicle shall be given a fairly heavy day's work, entailing at the same time a mileage not in excess of its battery capacity, including the energy that can be taken up by boosting. This mileage will vary from a hundred miles per diem for a passenger omnibus operating 14 hours, down to 30 miles for a six-ton lorry, engaged on railway work, entailing many stops and starts and a low speed of, perhaps, six miles per hour. An enormous internal town transport must be handled in every large town or city, and for this service the electric vehicle can, and will, displace the horse completely, whilst in many instances petrol and steam will also be supplanted for town work and used in their legitimate sphere of high-speed or long-distance transport. Such a distinction of function would simplify vastly the solution of many hitherto unsolved traffic problems, which become otherwise more difficult each day. Traffic congestion increases because *traffic speed* remains fixed on account of the horse and its most inadequate two miles per hour gait, this being coupled with a penchant for blocking the way for other road users, by taking the middle of the road!

The electric vehicle is to be regarded [illegible] as a potential means of displacing the horse, thus speeding up the traffic stream and also reducing very greatly the cost per ton of merchandise transported. In [illegible] that most costly form of energy [illegible] truck has often reduced the cost of handling [illegible] [illegible] Summing up then, we may assert that a [illegible] handle from three to five times the volume (weight) of traffic, if handled by electric vehicles than can be done with [illegible] existing conditions.

[illegible] in common with all other power [illegible]

The Simple Electric Chassis.

An illustration (Fig. 1) is shown in plan of a typical electric chassis of two tons loading capacity. A mere glance reveals the extraordinary simplification which can be gained in a power vehicle by employing accumulator cum electric-motor propulsion. Whilst, of course, such items as frame, springs, wheels, brakes, steering gear and allied details are common to both petrol and electric vehicles, there is no similarity as regards their respective power plants. The electric chassis represents ultimately the practical application in machine design of the principle of elimination. No cylinders, carburetter, valves, tappets, springs, plugs, magneto, pumps, cams, gear wheels, connecting rods, pistons, nor gear box, and clutch, with their complication of adjustments and relatively quick wearing detail work are needed on an electric chassis. A single series-wound electric motor suffices, with its perfectly balanced rotating armature, to perform all the functions of prime mover, with a reliability so marvellous that an attention of an hour or two per annum suffices to keep it up to highest working efficiency.

Referring again to the illustration, the crate carrying the accumulator will be seen; also the controller adjacent to the base of the steering pillar. In this type of chassis, transmission is effected in two stages; first, by bevel gear reduction within the countershaft, which, carrying sprockets at its outer ends, enables the second and final drive by roller chain to the rear wheels to be made. The accumulator is carried in halves on roller-supported trays, which can be pulled out sideways on rails, the side doors serving as supports when opened downwards. A safety switch provided with a removable pocket-key insures the vehicle against unauthorised operation under all conditions—a necessary precaution. A standard power equipment consists of 60 Edison cells of the A-8 type, giving an ampere-hour output of 300 and an average voltage of from 60 to 70, according to working conditions. The energy consumption can be gauged by reference to a Sangamo ampere-hour meter, the dial of which is in view of the driver. This instrument is calibrated in various ways, one of the most convenient being so that it affords an index at any moment of the energy remaining in the battery during discharge, [illegible] thus correcting for internal losses during the process of charging. As to detail work on the electric chassis, it should be remarked that particular attention is given by their makers to ensure continuously good lubrication of moving parts by grease or oil, according to requirements. Screw-down grease cups and lubricators are accordingly arranged to be easily accessible, while as regards wheel and motor bearings, these run on balls or rollers and are, under average circumstances, efficiently maintained by attention every few months.

Progress in the design and construction of road traction accumulators has been so rapid during the last few years that the element which originally gave unfavourable results and [illegible] has now attained a degree of mechanical robustness and electrical reliability which enables the [illegible] to be [illegible] with practical certainty [illegible]. [illegible] the electric vehicle industry became apparent. [illegible] commercial service [illegible] of the [illegible] all [illegible] cell with its alkaline electrolyte and the [illegible] "Exide" cell of lead and sulphuric acid, give reliable service over very extended periods. The [illegible] Edison accumulator [illegible] approaching its ninth year [illegible] justified the [illegible] claims for its extreme mechanical robustness together with freedom from chemical derangements or [illegible], [illegible] the "Exide" battery is also giving excellent results under many conditions of operation. The Edison accumulator is guaranteed for 60,000 miles or eight years' continuous service. A guarantee is also given, but on a different basis, for the "iron-clad" Exide.

Some Electric Vehicle Services.

Electric vehicles may be conveniently classified under three principal headings, depending on whether they are intended to run on common roads, on rails, or on specially flat floors, in which latter case they are termed "platform trucks." An approximate sub-division of the main services in which the electric vehicle is now being used is appended herewith:—

On Common Roads.	1. Commercial vans, lorries, wagons. 2. Municipal tipping wagons, water sprayers, pump wagons, breakdown vans, ambulances, fire engines, tower wagons, &c., omnibuses. 3. Town carriages, runabouts, taxis, invalid chairs, &c. 4. Tractors.
On Rails	1. Tractors and locos. 2. Platform trucks, &c.
On Floors and Platforms.	1. Trucks. 2. Tractors. 3. Elevating platform trucks. 4. Crane trucks.

This list is sufficiently extensive to indicate how wide is the scope for accumulator traction in our factories and workshops and as a means of performing many kinds of work which could only be done safely and conveniently by electrical aid.

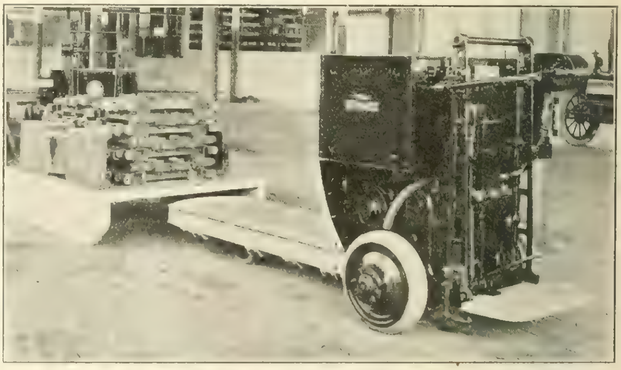


Fig. 2. Edison Automatic Elevating Platform Truck (Load Capacity 2 tons).

When it is recalled that there are, in actual service, in this country, so many different types of electric vehicles, operating in most cases under great stress and often in the care of unskilled (i.e., previously quite inexperienced) people, a vivid idea is afforded as to how exceedingly simple this type of machine is to maintain and work. At this point some observations on typical electric vehicle uses will be very relevant.

The Road Vehicle.

The field that is now and, moreover, is likely to remain the largest open to the electric, is that of town transport, preferably on hard or non-muddy roads and where the daily average distance is somewhere between the limits of 20 and 60 miles. Although the latter figure can easily be exceeded and is regularly surpassed in the rather special conditions of passenger carrying, yet it is extremely seldom that commercial town transport conditions would call for a daily radius of action exceeding the figure quoted. Vehicles of every loading capacity from a half ton to five tons have now been in constant operation for periods up to four years, and the results obtained more than justify the choice of electric vehicles instead of competing forms of power car. Not only have great economies in actual cost of operation ensued

invariably by adopting electrics, but, in addition, women have been found to be capable of driving them after a very short training. Moreover, the speed of the battery car has surprised many users; and as typical of this statement may be quoted a trial made by the owner of a fleet of cars, which demonstrated that on a trip involving 50 stops and made three times daily the time saved totalled 90 minutes in favour of the electric, against a 20 H.P. petrol car which had done the same duty. The energy cost was 50s. per week for petrol and 13s. 1d. *for the same service performed by electricity.* An estimated saving of nearly £200 per annum per vehicle is made in the case cited by using electrics for bread delivery.

An important feature of the accumulator car is that, when used for carrying foodstuffs, there is no possible danger of contamination by absorption of exhaust fumes or petrol vapour, a difficulty sometimes experienced with internal combustion engined vehicles. The extreme cleanliness of the electric has partly contributed to the decision of Messrs. Lyons, Ltd., to employ it for the immense distributing service to their numerous London depots, for which a fleet of some 10 machines is already in being. To Messrs. Harrods belong the distinction of operating nearly 90 electrics—many on food delivery service—the largest fleet in this country. Another extending service is that of milk distribution, for which the great London milk companies have used electrics for several years past, this work often entailing the vehicles being on the road 15 hours out of the 24. The cars leave the charging

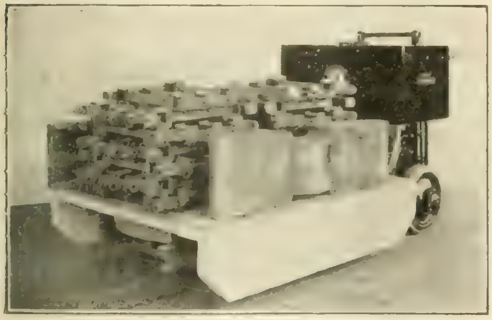


Fig. 3.—[illegible], London.

station at Messrs. Edison Accumulator Works at 5 o'clock in the morning, run their early collecting rounds from the railway termini and return for a two hours' boost at about 11 o'clock. They then go out for the afternoon collection, and finally return to garage about 8 o'clock in the evening, are washed down, cleaned, and then given a full charge for their early morning round. [illegible] service is practically run every day, all the year round, [illegible] about 16,000 miles per vehicle per annum, and speaks well for the ruggedness of the machines, which, driven by entirely unskilled drivers, are yet extremely seldom off duty for any reason save accidents.

The chassis used in the milk transport service are usually of two tons rated load capacity, fitted with float bodies and batteries of 300 A.H. capacity, giving an average mileage of from 40 to 50 miles per full charge. [illegible] is, unfortunately, [illegible] service, [illegible] form, on the average, the work of between two and three pair horse vans continuously. Other important food distributing firms who use electric vehicles are Messrs. [illegible], Ltd., London, who operate [illegible] in London, whilst in Glasgow the Co-operative Baking Society have [illegible] in service. A different sort of "food" is supplied by Messrs. Johnnie Walker, who do not believe in wasting spirit by burning it! Altogether there are upwards of 100 electrics now helping to distribute London's food, and the number is increasing steadily.

Scores of other trades have found the indispensability of the electric. Not only in London but in practically every city in the United Kingdom reports indicate a steady enlargement of the field wherever electric vehicles have been put into service suited to their special capabilities. Motor-car makers, lamp manufacturers, yarn spinners, dyers, foundries, breweries, steel mills, shipbuilders, ordnance constructors, explosives works, and an array of other trades far too long to enumerate, have all found that the electric vehicle supplies the missing link in their transport scheme, and have, accordingly, adopted it. Towns of such diverse road characteristics as Leicester, Dewsbury, Dunfermline, Sunderland, Pudsey, Manchester, Glasgow, Birmingham, Liverpool, Ipswich and Derby, are all using electrics on an increasing scale, and in fact it is now admitted that wherever there is a power station an electric vehicle can be profitably employed, especially where the station engineer offers the inducement of cheap energy for charging at one penny per unit or less, as happily is generally the case. A few exceptions to this sensible attitude must, however, be recorded where a supply is in the hands of some small-minded private company, bereft of imagination and hopelessly blind to their responsibilities as owners *pro tem.* of a vital public utility, the result being a scandalous overcharge for energy which will prevent in such unfortunate districts the use of electric vehicles. No doubt, in the future the enterprising garage owner who installs a power plant of his own will find that he can have a quite useful charging load which the ignorant business methods of such small-minded supply companies will divert into his grasp.

Fig. 4.—[illegible]

A large field for the employment of the electric vehicle has already developed in municipal service, particularly for tipping wagons, tower wagons, [illegible] and breakdown cars. The tipping wagon used for collecting domestic refuse in many towns has demonstrated its ability to increase largely the amount of work handled per day per man whilst reducing the cost per ton [illegible] to less than half that involved by horse haulage. Mr. Priestley, of Sheffield, in an important Paper read before the Conference of Cleansing Superintendents last May, showed that in his city the average cost of refuse collection had been reduced by as much as 18 per cent., the total saving for the year in these departments due to electric vehicles representing [illegible] per annum.

The Electric Lorry.

The vast changes [illegible] by war conditions have demonstrated [illegible] work to be done by the [illegible] can be better performed by [illegible] mechanism. Nothing could exceed the [illegible] of supplying [illegible] in which every mechanical output is needed. The use of the [illegible] is generally a [illegible] amount of [illegible] supplied energy. The work of the [illegible] with most surprising results in [illegible] economy, speed and [illegible].

Although war-time urgency has no doubt given the electric truck its chance, particularly in some of the enormous works which have been so rapidly called into being, there can be little doubt that a complete and permanent revolution is in progress in our methods of handling material and finished parts during manufacture. In future it will rightly be regarded as a *sine qua non* that in any factory of considerable area due provision shall be made for operating electric trucks from one department to another and from the packing and despatch section to the railway directly.

In general mechanical and electrical layout the electric truck is not greatly dissimilar to its big brother, the road vehicle; that is, as regards accumulator, transmission, controller, motor and frame. As the electric truck is designed for being used along narrow passages and tracks, and must, moreover, turn in a small radius, it is purposely made as small and compact as possible. Hence, length and width are reduced to the utmost, and platform height also, so that ease of loading and off-loading may be a maximum. From the illustration (Fig. 5) it will be seen that the driver stands in front of the machine facing the direction of travel, whether it be forwards or backwards. Steering is almost invariably by tiller, and control by lever operating in a vertical plane and arranged so that, normally, it *springs* into a neutral off-current position. The raising of one foot operates a mechanically applied brake, enabling the truck to be pulled up within

Fig. 5.—Lot on Elwell Parker Truck in Use at Euston Station, L. & N. W. Railway.

half a length (say, from 3 to 5 ft.) in emergency. Stepping off the operating platform altogether allows them both, brake and controller, to swing up, thus braking the transmission and cutting off current by a circuit breaker, in addition to that function being performed by the controller lever as stated. For plain platform trucks with chain drive single axle steering is employed, which has proved for many conditions to be perfectly serviceable. Totally enclosed transmissions, both of the spur and worm type, are usually employed, and, beyond doubt, will justify in the long run their higher first cost, besides possessing the virtue of silence [illegible] gear. This is particularly desirable where trucks are used in lifts or outside jobs carrying bulk [illegible]. All the good [illegible] that the use of ball and roller bearings, alloy steels and the like can confer have made the [illegible]

array of other jobs in the foundry, forge, dock, factory, and every situation where the common-sense step of abolishing the hand-truck has been taken. Just as on the road the electric vehicle is destined to displace the horse, so that the electric truck must supplant human motive energy in the factory. At several of the great London railway termini the electric truck may now be seen, and notably at Euston, Paddington and St. Pancras. Women have been found excellent as drivers of these handy machines, and at Euston the entire care of the electric trucks as regards driving and charging is in feminine hands. At St. Pancras a small tractor (a modified form of truck) may often be seen trailing behind it a long train of hand-barrows which under former conditions would have been separately pushed by manual labour: a typical example of the right and the wrong way of doing such work. The local Post Office electric trucks may be seen any night at Paddington, dealing with very heavy loads of mails which are transported, in some cases, nearly a quarter of a mile. The work which is done by one electric truck in this service is equal to that of from four to six men working hard and continuously. Other instances tell of 150 tons of paper being moved in a day of 12 hours by means of an electric truck, which machine saved the labour of 10 men and paid for itself within eight months. Also of loads of hundreds of tons per diem being transported from one shop to another in a huge engineering works, and of other similar experiences, wherever the electric truck has been applied with discrimination.

A very advanced type of electric truck is the form in which the load is first stacked by hand on to bridge-shaped platforms, the truck being then backed with its platform under the loaded bridge, which is then lifted by an electrically operated gear so that the truck now supports the load clear of the ground. The elevating platform type of truck can thus be kept busy practically continuously, as spare bridge platforms can be loaded whilst the truck runs backwards and forwards between loading and off-loading stations, thus reducing standing time to the vanishing point, and giving the same transporting efficiency as would be gained by employing a willing giant working on piecework! Operating expenses for an average truck will be covered by a sum of some 10s. per week, and will not even in the most severe service exceed double this sum. The electric truck is amazingly economical in energy consumption, and will, in fact, run about 20 miles for a shilling, more or less, according to the type of machine considered. In all cases labour is the principal item of expense, and it is this commodity with which the electric truck dispenses in most wholesale fashion.

Many types of truck are now available, according to requirements, both as to kind and amount of load to be carried, including the tiny platform truck which must not be too big to go into the lift, to be raised and lowered from floor to floor, and also the relatively enormous baggage truck used by railway companies and others for loads which are both heavy and bulky. It often pays to put down special concrete paths where electric trucks are to be operated; also to board between the rails where crossover places on the works railway are arranged. By such means the electric truck can deal with the heaviest amount of work for least energy consumption. An average truck is designed to be able to run up short inclines of about one in five gradient with full load.

In this new field electricity has again proved itself to be the only convenient motive energy available. Neither petrol, steam nor compressed air could indeed be applied to such work. Wherever the hand truck can go the electric truck can follow it—and displace it.

There are at the moment of writing between 300 and 500 electric trucks in service in this country. Room exists for at least 20 times that number, entailing a saving in wages paid, [illegible] productively, of about £10,000,000 per annum. Such waste cannot be afforded in any efficient manufacturing country.

CORRESPONDENCE.

THE GIVING OF PROXIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your leader on the subject of "The Giving of Proxies" prompts me, as one of those who gave their proxies and does *not* regret the fact, to place before you the reasons why I am unable to agree with the argument you use.

I believe it is a fact that the action in question was not originated by the Council but by certain members quite independently, and it is evident from the details sent by the member involved that the matter has been receiving the attention of the Council for nearly a year.

That being so, it must, I think, be also evident that the Council, having had opportunity for lengthy and careful consideration, is much more likely to give a decision unbiassed by any special appeals one way or the other, such as might sway those present at a meeting many of whom would, of necessity, give their personal decision on the matter with only a mere fraction of the intimate knowledge possessed by those of the Council who have had the matter under consideration, and it must be presumed that the members nominated by the Council on the proxy papers are members who are fully informed on the matter.

I believe I am correct in saying that the Council of the British Medical Association and also the Council of the Bar, deal with such matters as the one under consideration without reference to the general membership, and the only improvement on the procedure adopted in this case that I could suggest, would be for the members to give a postal vote for the election of a special tribunal of, say, four members, with the president as chairman, [illegible] full powers to hear both sides of the question and to give a formal decision.

Such a decision [illegible] the nature of things be of a far more judicial nature than can possibly be arrived at by any other method, but, failing the possibility of its being adopted, those of us who gave our proxies to the Council did so in the full belief that the Council would not take such extreme action against any member without full cause, and without being sure that it was in the best interests of the Institution, and I, for one, am content to leave the matter in their hands.

I am, &c.,

Watford, Dec. 8. M. I. E. TUNLEY.

[Although much may be said in favour of some of the views expressed by our correspondent, the fact remains that if proxies are so used it is a farce to call upon a member to defend himself at a meeting, because the verdict can only be in one direction, on account of the overwhelming number of proxies.—ED. *E*.]

DEFECTIVE METER READING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The case referred to in your issue of Dec. 7 reminds me of a more or less iniquitous proceeding on the part of some supply authorities.

A consumer is charged so much per unit with a minimum charge per quarter. The charges are sent in each quarter. During one quarter there is no chance of the consumer reaching the minimum charge.

The meter is read *some days or even weeks before* the end of the quarter and the minimum charge made. The units consumed in the time that elapses between the reading of the meter and the end of the quarter go into the next quarter. But apart from this, various possible contingencies may arise. When a minimum charge is made, should not the consumer be credited with having used an equivalent number of units which will *not* appear in the next quarter's bill and so be charged for twice [illegible]

I am, &c.,

Manchester, Dec. [illegible] [illegible]

[We do not think there is much to be said in favour of our correspondent's complaint. [illegible]—ED. *E*.]

ARRANGEMENTS FOR THE WEEK.

FRIDAY, Dec. 14th (to-day).

INSTITUTION OF MECHANICAL ENGINEERS.

6 p.m. At the Institution of Civil Engineers, Great George-street, Westminster, London, S.W. Paper on "The Use of Soap Films in Solving Torsion Problems," by Messrs. A. A. Griffith and G. I. Taylor.

ELECTRO-HARMONIC SOCIETY.

8 p.m. At the Holborn Restaurant, London, W.C. Smoking Concert. Chairman, Mr. H. Scholey.

JUNIOR INSTITUTION OF ENGINEERS.

8 p.m. At 39, Victoria-street, London, S.W. Paper on "[illegible] Rotary Engine and Rotary Pump," by Dr. W. E. Lilly.

MONDAY, Dec. 17th.

ROYAL SOCIETY OF ARTS.

4.30 p.m. At John-street, Adelphi, London, W.C. [illegible] on "Progress in the Metallurgy of Copper," by Dr. H. C. H. Carpenter. (Lecture III.)

SOCIETY OF ENGINEERS.

5 p.m. At the Geological Institute, Burlington House, Piccadilly, London, W. Lecture on "High-speed [illegible] [illegible] the War," by Mr. C. Kearney.

TUESDAY, Dec. 18th.

INSTITUTION OF ELECTRICAL ENGINEERS (NEWCASTLE [illegible]).

[illegible] p.m. At the Mining Institute, Newcastle. Address by the President.

THURSDAY, Dec. 20th.

GREENOCK ELECTRICAL SOCIETY.

7.45 p.m. At Masonic Rooms, 22, West Stewart-street, Greenock. Paper on "Fuses and Circuit Breakers," by Messrs. M'Dougall and Toppin.

FRIDAY, Dec. 21st.

ILLUMINATING ENGINEERING SOCIETY.

[illegible] p.m. At the Royal Society of Arts, John-street, Adelphi, W.C. Presidential Address by Mr. A. P. Trotter.

VOLUNTEER NOTICES.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Oxford-street, W. [illegible]

Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.

Orders for the Week.

Officer for the Week: Sec. Lieut. F. [illegible]

Next for Duty: Sec. Lieut. F. A. [illegible]

Drills. Week ending Friday, Dec. 21, 1917.

Monday: No. 3 Company, Left Half, Recruits' Squad, [illegible] 6.30.

Tuesday: Physical Drill and Bayonet [illegible] 7.30.

Wednesday: No. 1 Company, 6.30.

Thursday: No. 2 Company, 6.0. Signalling [illegible] 6.30.

Friday: No. 3 Company, Right Half, Recruits, 6.30.

Musketry: Belvedere-road, Tuesday, Wednesday and Thursday, [illegible]

Note.—Christmas Holidays.—Headquarters and the Range will be closed from the 22nd to the 28th, both inclusive. The Medical Officer will attend for the Examination of Recruits, &c., on Thursday at 6.30. Unless otherwise indicated, all [illegible] will take place at Headquarters.

LEGAL INTELLIGENCE.

Attorney-General v. Metropolitan Borough of Hackney.

Legal arguments in this appeal were concluded on Friday [illegible] and their lordships reserved judgment.

Mr. A. J. Walter, K.C., who [illegible] on behalf of the Metropolitan Borough of Hackney, [illegible] [illegible] maximum demand at £1 [illegible]

[illegible] 548 units. Any customer with a lower load factor, say 12½ per cent. [illegible] mere light user) used, on the other hand, 12½ per cent [illegible] in the quarter—viz., 274 kw.-hours—so that the 240d. he [illegible] kilowatt was only spread over 274 units. In each case the customer paid a fixed charge of ½d. per unit in addition, but the maximum demand payment automatically adjusted the charge per unit according to the load factor. No case had been suggested of unfair discrimination between power users; and, in fact, (1) on the scale complained of every power user had the same right of using 20 per cent. of the total supply as for light; (2) the scale complained of was only available for factories and workshops. If a man used power alone, he paid less per unit of his maximum demand scale than the man who used power and light, owing to the automatic working of the load factor, as already explained in distributing the 240d. (viz., £1 per quarter per kilowatt demand) over more or less units.

Mr. COLEFAX then replied on behalf of the appellants.

Holt v. A.E.G. Electric Co.

On Dec. 5 a settlement was arrived at in the action brought by Mr. A. Holt, London commercial manager of the A.E.G. Electric Co., for the recovery of his salary under an agreement, notwithstanding he had been called to the Army. The company, which is being wound up under an order of Board of Trade, by its Controller, admitted that it was a case in which a payment might be made, but raised the objection that under sec. 1 (7) of the Trading with the Enemy Act, the action could not be brought without the consent of the Board of Trade.

His lordship directed that the sum agreed upon in chambers should be paid to plaintiff in full settlement of his claim, holding that the section relied upon did not preclude plaintiff from bringing his action without the consent of the Board of Trade. He also explained the principles on which the Trading with the Enemy Acts are administered. He said that there were two widespread misconceptions. The first was that, because of undue susceptibilities for enemy interests, there was "hesitation" and "delay" in paying the debts of British creditors out of the vested property of enemy debtors. The second was that in the winding up of enemy businesses undue consideration was shown towards the enemy owners of those businesses. He admitted that there was "hesitation," as a general rule, in paying the debts of enemies, but he referred to the difficulties of adjustment and to the objects of the Acts which, he said, were not primarily for the benefit of creditors at all. He added that it was [illegible] to the controllers appointed by the Board of Trade to wind up [illegible] to suggest that they should not guard against unfounded and inflated claims.

ELECTRICITY SUPPLY.

EXTENSIONS.

Burton-on-Trent. Subject to the [illegible] consent, a scheme is to be carried out for extensions at the electricity works at a cost of [illegible].

The extensions include a turbo-alternator, £19,500; foundations, £2,000; [illegible] £2,400; [illegible] £1,000; [illegible] £1,000.

Derby. The Council propose to expend [illegible] [illegible]

[illegible] Coal Controller, but the committee were only referred from one depart- [illegible]

Eccles. [illegible]

Gloucester. [illegible]

GENERAL.

Birmingham. On behalf of the youths engaged as manual workers by the Corporation Electrical Supply Department, application has been made for a 25 per cent. advance in pay for night shift work (engineers and switchboard attendants) and time-and-a-quarter for sub-station youths.

The youths are said to be members of the Electrical Trades Union, whose secretary (Mr. A. Beardmore) has intimated that unless the advances are conceded strike methods will be adopted. The question is being considered by a conference of representatives of the department and the workers.

Mr. P. J. Burgess, secretary of the Midland Electric Power Supply Engineers' Association, intimates that all the shift engineers at the Corporation electrical generating stations are members of his association and there is no authority for the statement that they are coming out on strike if the demands of the Electrical Trades Union are not conceded, as "these methods do not appeal to the members of the Power Supply Engineers' Association."

Dublin. Last week the Council considered reports of the city treasurer (Mr. E. W. Eyre) and the city accountant (Mr. Mangan) on the financial position of the electricity undertaking.

Special attention is called to the bank overdraft. The cash debit on March 31, last amounted to £38,788 17s. 4d. exclusive of £5,455 19s. 8d., which should be set aside for renewal accounts. The overdraft has since reached nearly £50,000 and although the figure, which is fluctuating, may be reduced before the end of the financial year, it must be noted that under the present system of financing the undertaking, the greater the development of the business the greater does the overdraft tend to become. Owing to the fact that consumers' accounts are furnished only quarterly, while expenditure in wages and for materials goes on month by month, working capital is necessary. This may be obtained by a loan, a reserve created out of the profits, or a bank overdraft involving payment of interest. The Corporation failed to obtain sanction for a loan. A reserve, though desirable, could only be built up gradually during years, and during the year ending March, 1917, the deficit on working was £1,575 against a surplus of £8,840 in the preceding year. This result does not compare unfavourably with results in other cities, but it is evident that under present conditions a reserve cannot be accumulated. The credit balance on the undertaking at March 31 was £9,961, and pending the increase of this figure to, say, £50,000 a cash overdraft will remain. It is suggested that the Electricity Committee should consider whether a revision of prices is advisable.

Regarding the third method of arriving at a working capital, viz., obtaining an overdraft, the report says that the question has now become acute, as, while formerly a credit balance on the capital account frequently existed as a set-off against a debit balance on revenue account, no money is at present available in the capital account. The Corporation has no legal power to pay interest upon an overdraft, and whatever may be said as to the wisdom of this disability in the case of ordinary civic expenditure, no one can question the absurdity of denying to a great trading concern the banking facilities available to ordinary commercial concerns. Such facilities are possessed by many English municipal trading enterprises, and the report recommends that the Council take steps to obtain permission to pay interest on the overdraft for such a period as may be necessary. It is said that a precedent exists in the power lately granted to the L.G. Board to sanction payments of interest on overdrafts in connection with food production. The present position has become absolutely untenable, and the Corporation should approach the Chief Secretary to obtain powers by emergency legislation or otherwise to pay interest as recommended.

In a report regarding the deficit of £1,575 8s. 9d. on the working for the year ending March 31, 1917, the Secretary points out that the increased rate of charge put on for the war period brought an extra income of £13,298, against an increased expenditure of £25,576, made up as follows:—Coal cost for year was £36,825 (as against normal cost of same tonnage at £20,730), leaving an increase of £16,095; loss of supply to burned-down houses, £5,500; increase in cost of materials for maintenance, £650; increase in wages bill £895; in rates and income tax £1,618; in cost of collection, £522; army allowances £296. The difference between the increased expenditure over the increased receipts is thus £12,278. Although the units sold show an increase of 2,559,700, the increase was almost wholly in power units. For pumping, 1,148,000 units were supplied to the Main Drainage Department at cost prices and [illegible],000,000 units were sold to the Munitions Department at only very slightly over cost price. The reduction in civic expenditure on lighting has also affected the electricity department. The expenditure on maintenance, owing to increased cost, remains almost unchanged—viz., £3,264 in 1917, against £3,328 in 1914. The amount credited to the department from the rates was reduced by £1,000. The total units sold to private consumers were 7,091,729 in 1914 and 9,651,425 in 1917. Further, owing to the increase in the power units, while the lighting units remain almost unchanged, the average price obtained for units is the same (viz., 2·66d.) for both 1914 and 1917, whereas the total cost, including capital charges, has increased from 2·61d. in 1914 to 2·78d. in 1917.

The city accountant's recommendation was adopted.

Electric Supply Extensions. In the House of Commons last week, Mr. [illegible] asked the Minister of Munitions who was the controller of the electric power supply at the Ministry of Munitions, had he the power to refuse priority certificates to municipalities who were anxious to extend their plant not only to meet additional loads, but to secure effi- [illegible] that until recently the controller of the electric

supply was one of the consulting engineers to the largest electric company in County Durham ; that when he relinquished the appointment to go to another Government Department he was followed as controller of the electric power supply by the manager of a company which was affiliated with or was a part of the above company ; and, in view of the past conflict between the municipalities and the companies for the monopoly of the supply of electric power, would he consider the desirability of taking out of the hands of officials interested in companies the power to restrict the development of municipal electricity supplies ?

SIR L. WORTHINGTON EVANS said the present director of electric power supply was Mr. Arnold Gridley. Priority certificates were issued by the Priority Department of the Ministry of Munitions after consultation with the Supply Departments of the Ministry. The late Controller held the appointment mentioned ; he was appointed to the staff of the Ministry because of his experience. The reply to the fourth question was in the affirmative. The reply to the fifth question was that he was satisfied that the late and present directors of electric power supply had done excellent work in connection with the supply of electricity throughout the country, and he did not consider there was any occasion for, or that there would be any advantage in, making a change.

Rotherham. The agreement for the purchase by the Corporation of the electricity undertaking of the Mexborough & Swinton Tramways Co. has now been signed by both parties.

Sheffield - Rotherham Electric Supply Scheme. --Aldermen Sir William Clegg, Hobson and Styring, and Councillors Bailey and Warlow have been appointed representatives of the Corporation on a Joint Committee which is being formed to consider the question of electricity supply in Sheffield, Rotherham and adjacent districts.

West Hartlepool. The borough electrical engineer (Mr. J. W. Spark) has been authorised to apply to the Board of Trade Coal Mines Department for powers to disconnect unessential consumers.

ELECTRIC TRACTION.

Board of Trade Tramway Control Committee.—A meeting of tramway managers (Mr. Jas. Dalrymple presiding) was held on Dec. 6 at Stirling to consider the non-representation of Scotland on the committee appointed by the Board of Trade for the control of tramways.

It was decided to ask the Board of Trade to appoint as a member of the committee some person who is resident in Scotland, and who knows the conditions under which the tramways of the country are worked.

It was announced in the House of Commons last week that it was not proposed to pay salaries to the chairman or members of the committee.

Darwen. Mr. F. J. S. Hoskens, tramways manager, has been authorised to accept an appointment as assistant dilution officer under the Ministry of Munitions at Manchester. Mr. Hoskens remains manager of the tramways, and will give attention in the evenings to the department without salary.

Glasgow. A serious tramway accident occurred on the evening of the 5th inst., when a tramcar was overturned while turning a sharp corner from Queen's drive into Victoria road, and two passengers were killed and over 50 injured.

Leeds.—The City Council has referred back a recommendation of the Tramways Committee to suspend halfpenny fares during the period of the war, except in certain cases.

MISCELLANEOUS.

Award of the Committee on Production. Correspondence has passed between Mr. H. Faraday Proctor, of Bristol, the honorary secretary of the I.M.E.A., and the Committee on Production, in regard to the award of the Committee on Production on Nov. 6 of [illegible] per week for the engineering and foundry trades. The Committee has now decided that the [illegible] payable for the first pay week in December.

French Carbon Export Prohibited. [illegible]

Marriage. [illegible]

Non-Ferrous Metal Industry Bill. [illegible]

The New Trade Intelligence Department. [illegible] daily and trade newspapers on Dec. 6, and gave information as to the origin, organisation and proposed work of the new Department.

The formation of the new department was brought about by the fact that there had been some difference of opinion between the Foreign Office and the Board of Trade as to which department should control the Consuls and Commercial Attachés. A committee appointed to deal with the subject came to no conclusion, and it was decided to form a joint department. This was not a compromise. [illegible] tiations in a foreign country might at any moment develop a political aspect. The Baghdad Railway was a commercial proposition, but involved important political considerations. The venture of a joint department was in its essence a good one, provided the two great departments concerned worked together with good will, as he believed they would. The new department would absorb the Commercial Intelligence Department of the Board of Trade, the War Trade Intelligence Department of the Foreign Office, and the Foreign Trade Department of the Foreign Office. The direction of the Commercial and Consular Department of the Foreign Office would also be placed under his supervision, and ultimately all these would be combined in a new building under his direction. The Foreign Trade Department of the Foreign Office dealt with the placing of enemy traders on the statutory list, and with the substitution of friendly firms. That work would also be assimilated by the new department. The United Kingdom would be grouped according to trade and industry, and the overseas countries in sub-sections, geographically, so as to bring the two readily and easily in touch. The Department would collect information, and would also have the power to take action in matters relating to trade. It was hoped to prevent overlapping by carefully delimiting the sphere of action of the Board of Trade and the Foreign Office. As a general rule, when a subject concerned a whole class of industry in this country, such as a commercial treaty, it would be reserved to the department which dealt with commercial treaties in the Board of Trade. Business predominantly political and not commercial would be dealt with by the Foreign Office. Apart from these reservations, the new Joint Trade Intelligence Department would deal with all questions affecting the welfare and the promotion of the trade of the country. An Advisory Committee of experts in trade and business matters would be appointed in connection with the new department. The scheme could only be made a success with the co-operation of the business world and the advice and help of its representatives. The *Board of Trade Journal* would be conducted upon a new and improved system, details of which would be published later.

The status of Trade Commissioners of the Board of Trade dealing with the trade of the British Empire, and of Consuls and Attachés of the Foreign Office concerned with trade in foreign countries was to be improved, and their emoluments were to be increased. The best men would be obtained, and they would be men with business experience. Before the war the Germans employed a commercial strategy as real as the military strategy they are employing to-day. There was a perfect system of penetration by German finance and industry, and although we did not wish to copy it they had to meet it, and it would be no good going along in a happy-go-lucky way.

The offices of the new Department are at present at 73, Basinghall street, E.C., but are to be transferred to a building [illegible] Foreign Office, Downing street, S.W.

Trade After the War.—It is reported that Lord Balfour's Committee on Trade After the War has now presented its report.

There are three documents, a majority report and two minority reports. One of the minority reports (signed by Lord Faringdon and others) advocates the imposition of [illegible] 10 per cent. on imported manufactured and semi-manufactured goods, lower duties to be imposed by arrangement with foreign countries.

[illegible] to be below 10 per cent.

[illegible]

Tungsten and Preston Features. [illegible]

TENDERS INVITED AND ACCEPTED.

Turbo-Alternator with Condensing Plant.

The Electricity Committee of BOLTON Corporation invite tenders for the supply, delivery and erection of a 7,500 kw. Turbo-alternator, with condensing plant. Specification and form of tender from Mr. W. J. H. Wood, borough electrical engineer, Back o' the Bank, Bolton. Tenders to the town clerk, Mr. Samuel Parker, Town Hall, Bolton, by noon Jan. 15. *See an advertisement.*

Electrical Fittings, &c.

BRIGHTON Guardians require tenders by 10 a.m. Dec. 18 for the supply of electrical fittings, ironmongery, &c. Forms of tender from the Clerk, Princes'-street, Brighton.

Telephone Service.

ROSARIO (Argentina) Municipality recently invited tenders, which are to be opened on Feb. 23, for the provision of a telephonic service within the district of the municipality.

DERBY.—The Council has accepted the tenders of G. Fletcher & Co., for a coal elevator, at £880, and E. Morley & Sons, for an electric jib-crane, at £350.

GLASGOW.—The Corporation have accepted the tender of Bruce Peebles & Co., for two 500 kw. rotary converters, at £2,200 each, plus £65 for spares; British Thomson-Houston Co., three 1,000 kw. rotary converters at £3,768 each.

The order for tramway cable has been given to the Liverpool Electric Cable Co. and General Electric Cable Co.; for trolley cord to J. Cookson (Ltd.); rotary converter to British Westinghouse Co.; and for galvanised steel wire to Whitecross Co.

SALFORD.—The Electricity Committee has accepted the tender of W. T. Glover & Co., for supply of paper insulated lead-covered cable required in connection with the supply of electricity to P. R. Jackson & Co., £570 5s. 8d.

SHEFFIELD.—The City Council has accepted the following tenders: J. W. Harrison (Ltd.), c.i. pipes; A. Reyrolle & Co., a further 30 panels of e.h.t. sub-station switchgear; Foster Bros., pipework; Edward Bennis & Co., suction ash plant; R. White & Sons, lifts and rails.

SWANSEA.—The Electricity Committee recommend the acceptance of the tender of the British Thomson-Houston Co. for a 5,000 kw. turbo generator for the electricity works, at £25,516. There were five tenders.

APPOINTMENTS VACANT AND FILLED.

One or more full-time teachers of technical electricity, electrical engineering and wiremen's work are wanted for the day classes for training disabled soldiers at Leeds Technical School. *See advertisement.*

Wolverhampton Corporation invite applications for the position of commercial secretary in connection with their electricity department. Salary £300 per annum. Particulars from Mr. S. T. Allen, borough electrical engineer, Commercial-road, Wolverhampton. Applications to the Chairman, Electricity Committee, Town Hall, Wolverhampton, by Dec. 27. *See advertisement.*

A meter superintendent is wanted by the Calcutta Electric Supply Corpn. (Ltd.), 2, Broad-street-place, London, E.C. 2. *See an advertisement.*

Applications are invited for the position of chief assistant electrical engineer in the electric supply department of Birmingham Corporation. Salary £750 per annum. Forms of application, &c., can be obtained from the Secretary, electric Supply department, and applications to be sent to the Chairman, Electric Supply Committee, 14, Dale End, Birmingham, by noon Dec. 17.

A junior shift engineer, with experience in e.h.t. a.c. and l.t. d.c. three-wire supply is required at Barnsley electricity works. Applications to the acting borough electrical engineer, Mr. T. W. Hibbert.

An advertiser requires an estimator for electrical control gear in controlled establishments on south coast.

Mr. J. B. Hudson, deputy electrical engineer at Bootle, has been appointed Borough Electrical Engineer of Leigh (Lancs.), out of 111 applicants.

BUSINESS ITEMS.

Patent Development. The owner of patent No. 28,630/1913, relating to "electrolytic converter for the transformation of alternating current into continuous currents," wishes to enter into arrangements for working the invention. Particulars from Messrs. [illegible] Bros., 84 86, Chancery-lane, London, W.C. 2.

LIQUIDATION.

A meeting of the creditors of the National Provincial Electricity Corpn. (Ltd.) will be held on Dec. 20 at the office of the liquidator Mr. S. Gallatt, Balfour House, Finsbury pavement, London, E.C. 2.

COMPANIES' MEETINGS AND REPORTS.

CAPE ELECTRIC TRAMWAYS (LTD.)—Mr. L. Breitmeyer, who presided over the meeting last week, said there was a serious falling off in the traffic receipts during the first four months of the financial year, but since November 1916, a marked recovery had set in. In fact, the number of passengers carried on the Cape Town and Port Elizabeth systems was the highest on record, and reached 23,752,016 passengers, with a gross revenue of £231,105, or an increase of 1,274,650 passengers, and in traffic receipts an increase of £18,314. 0s. 3d. over previous year. The working expenditure of £140,773 unfortunately was also a record and was greatly in excess of that in normal times. The profits transferred, however, show an improvement of £6,225. 9s. 1d. In Cape Town, owing to an unusually dry season, a very serious water famine was experienced, which necessitated the undue use of salt water for road watering, to the detriment of their permanent way. Of course, salt water corroded the rails more than ordinary water. Another difficulty had been the ever-recurring changes among the employés in these disturbed times. The Port Elizabeth system did not suffer so much from those disabilities, and had run quite smoothly throughout the year. After paying debenture interest and amortisation and adding £7,983. 7s. 6d. brought forward, the available amount was £39,152. 5s. 9d. Of this sum £12,000 has been set aside to reserve, and the directors recommended a dividend at rate of 5 per cent. on the capital, leaving £2,591. 3s. 9d. to be carried forward.

EDISON SWAN ELECTRIC CO. (LTD.)—For the year ended June 30, 1917, the profit is £34,681 6s. 2d., from which has to be deducted interest on both classes of debenture stock (£15,986 11s. 11d.), leaving £18,694 14s. 3d., which, added to £4,025 8s. 4d. brought forward, leaves £22,720 2s. 7d., which the directors have dealt with as follows :—Munition levy to June 30, 1916, £7,295 and writing down expenses of issue of preference shares £2,158 9s. 6d., carrying forward to next year £13,266 13s. 1d. The capital expenditure during the year, before providing for depreciation, amounted to £10,900, of which £3,400 is in respect of additions to buildings and £7,500 to plant and machinery, the latter being almost wholly for extensions to the lamp works. The profits, taking into consideration the difficulties which the company had to contend with, are as high as the directors had anticipated. The proceeds of the issue of the 100,000 preference shares was not available for the business until within a few days of the close of the financial year. Although every endeavour has been made, in entering into contracts, to provide for the increased cost of production arising from time to time by the rise in wages and cost of raw materials, it has been found impossible to synchronise the price obtainable for the company's products with the spasmodic and rapid advances in wages, over which the directors had no control, and this is reflected in the reduced gross profits earned. With the advent, however, of the new capital, enabling the company to take full advantage of discounts upon some of the raw materials purchased and generally to buy on better terms, it is hoped that the accounts for the current year will show more encouraging results. The engineering side of the works has been, and still continues to be, almost wholly employed on Government orders. The output of lamps has suffered in consequence of large numbers of skilled employees, trained at the expense of the company, leaving to take up munition work elsewhere, necessitating the training of fresh workers. This difficulty has to some extent been overcome, and since the period covered by the accounts the output of lamps has largely increased and manufacturing costs have been somewhat reduced. The company's operations abroad have been much hampered by reason of the difficulties in obtaining adequate shipping freights, resulting in the Colonial branches not showing that expansion they would have done under normal conditions, and satisfactory profits cannot be looked for in this direction during the continuance of existing conditions. The anticipated profits have been still further reduced, to the extent of approximately £2,500, by the fact that the Company's holding in deferred shares of Altrincham Electric Supply (Ltd.) has, during the past year, produced no return, that Company's operations having been affected by the Daylight Saving Bill, general economies in the use of current for domestic lighting and the high price of coal. Additional power contracts, however, have recently been entered into and it is hoped that a fair return from these shares will be forthcoming during the current year.

INDIA RUBBER, GUTTA PERCHA & TELEGRAPH WORKS CO. (LTD.)—For the year ended Sept. 30 the accounts show, after making provision for doubtful debts and a contingencies reserve, which includes excess profits duty, a net profit of £162,119 9s. 9d. Adding £40,216 [illegible] 4d. brought forward and deducting dividend on the preference shares paid in [illegible] £12,000, and interim dividend on ordinary shares paid in [illegible], and a sum of £[illegible] transferred to reserve fund, the disposable balance is £12[illegible] [illegible] 1d. The directors recommend payment of a final dividend of [illegible] per share (tax free) to the ordinary shareholders, making 10 per cent. for the year, and voting £30,000 to the officers' and employees' staff fund, leaving to be carried forward £[illegible] [illegible] 1d.

CITY NOTES.

EASTERN TELEGRAPH CO. (LTD.)—The company announce payment on Jan. 1 next of dividend at the rate of 3½ per cent. per annum (less tax) on the preference stock of the company for the quarter ending Dec. 31 next, and the third quarterly interim dividend of 1[illegible] per cent. on the ordinary stock (tax free) in respect of profits for the year ending Dec. 31, 1917. The transfer books will be closed from Jan. 7 to 14 inclusive.

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

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CONTENTS.

SPECIAL NOTICE.

"The Electrician" next week, will be published on Saturday, instead of Friday, on account of the holidays.

Notes.

The Non-Ferrous Metal Industry Bill.

THERE are many who look askance at any measures taken in restraint of the ordinary methods adopted in trading. On this account, no doubt, a somewhat keen opposition has been noticeable to the Non-Ferrous Metal Industry Bill which is now before Parliament, the object of the Bill being to stop certain German methods. These methods at first sight seem harmless enough. Why, it is asked, should not a German syndicate control mines in our Colonies, just as much as an English syndicate? The inhabitants of the Colony have the benefit of working in the mines, and if we wish to purchase some of the output we are free to do so. Actually, however, the position does not work out so simply. The object of German methods appears to be much less evident than might be thought at first sight. The result, as far as this country is concerned, has been that we have in the past been unable to obtain all we required of certain raw materials, and the ultimate result was that Germany could obtain as much as she desired and was able to make us dependent upon her manufacturers. In peace time this was unsatisfactory enough, but in time of war it became intolerable. For example, the supply of high-speed tool steel was much less than we required, and this was true also of spelter, with the result that our output of munitions was seriously hampered on the outbreak of war. German commercial methods appear to be very insidious in their objects, and we should indeed be an afflicted nation were we to allow important raw materials in our dominions to be controlled in future by German syndicates. We note that the Council of the Institution of Electrical Engineers has expressed its approval of the Bill and we think that all those who realise something of the position will not hesitate to support the Bill even though they very rightly detest a tendency of Government interference with trade.

Discovery and Invention.

IN his interesting Trueman Wood Lecture, before the Society of Arts, Sir DUGALD CLERK refers to the somewhat speculative question of the relative merits of discoverers and inventors. He very truly remarks that, contrary to the assumption frequently made, discoverers are not as a rule inventors, nor are inventors discoverers. In physics and chemistry the discoverer brings to light new phenomena; the inventor, on the other hand, attempts to apply known laws and known properties to an industrial or useful purpose. That the work of inventors is not usually performed by the discoverer or investigator is shown in a marked way by the records of the Royal Society. Of the presidents, only four can be considered to be inventors—namely, Sir HUMPHRY DAVY, the EARL OF ROSS, Lord KELVIN and Lord LISTER; yet the remaining presidents, seventeen in number, were men of the highest genius, recognised for their work of investigation. Perhaps this fact is sufficient to account for the idea, probably fostered by purely scientific people, that discovery requires a higher order of mind than invention. Comparisons of this kind are always difficult, being somewhat akin to the photometric comparison of red and blue sources of light. A result is obtained, but its interpretation is doubtful. There is, however, one outstanding difference, this being that discoveries are often the result of chance, whereas this rule is not the case with inventions. We believe, for example, that the discovery of Röntgen rays was the result of a chance observation, this observation being, of course, carefully investigated. On the other hand, we do not remember any invention which does not depend largely upon the systematic pursuit of an object.

Alleged Preferential Charges at Hackney.

OUR readers will remember that last summer the Gas Light & Coke Co. brought an action against the Hackney Borough Council, alleging preferential charges for electricity supply. Mr. Justice ASTBURY gave his decision in favour of the Hackney Council, and this judgment has now been unanimously upheld by the Court of Appeal. We have no sympathy for preferential charges, as we have indeed stated on previous occasions, but there is no reason for trying to make out that every consumer can be supplied with electric power on the same terms. So long as consumers purpose the same type of service, that is so long as it costs the supply authority the same to supply the different consumers, the charges should be on the same basis. In other words, so long as different consumers are supplied, as provided by the Electric Lighting Act of 1882, under "similar circumstances," the similarity being from the electrical point of view, they are entitled to be supplied on the same terms. This, however, is not good enough for the gas industry. We were under the impression that contentious matters of this kind between the electrical and gas industries had been dropped during the war. Unfortunately, this does not appear to be the case. We hope that there will now be a change in policy. Actions of the present kind are merely an attempt on the part of the gas industry to thwart the proper development of the electrical industry. No good can come of such tactics, and the sooner they are dropped the

better. We hope that the unanimous judgment of the Court of Appeal will put an end to this waste of energy, and that in future the gas interests will devote their efforts to a better purpose.

Tramway Accidents.

YET again there has been a regrettable tramway accident of a serious character, this time at Glasgow, and the resulting inquiry has shown that it was due to the extreme lack of experience on the part of the driver. In this instance the driver was only a lad of 16, who had obtained experience over quite a short period. Tramway managers must surely know by now that the driving of a tramcar is somewhat arduous work, and for this reason we think that women should certainly not be employed for this purpose; also considerable experience is necessary before it can be said that a driver can take a car on any route with safety. In our opinion, if the young men must join the colours, then the Government must see to it that there is a sufficient supply of older men to carry on the minimum tramway service that is required. It is useless to suppose that this work can be done by either women or by inexperienced lads, or, for that matter, by inexperienced men.

Institution of Electrical Engineers.—NON-FERROUS METALS BILL. The Council of the Institution of Electrical Engineers has passed the following resolution, which has been transmitted to Sir Albert Stanley:—

That the Council of the Institution of Electrical Engineers welcomes the Non-ferrous Metals Bill, approves its principles and congratulates the President of the Board of Trade on its introduction. The Council, representing an Institution whose members are interested so widely in the supply of non-ferrous metals, unanimously supports this measure designed to keep the control of the supply of these essential metals in British hands.

Classification of Electrical Engineers for Government Service.—A form is being distributed amongst members of the American Institute of Electrical Engineers, similar to that issued to members of the American Society of Mechanical Engineers on June 1st, inviting members to specify the nature of services which they are prepared to render to the United States Government and the fields in which they have special knowledge. Other societies are taking similar action, and it is hoped that by this means a complete record of the services available will be compiled in a single index in a central bureau.

Motor-Cycle Standardisation.—The standardisation of parts for motor cars, motor cycles and aeroplanes for war purposes is being much discussed in the United States. A recent issue of the "Journal" of the Society of Automobile Engineers proposes a detailed schedule for motor cycle parts under centralised control, as well as the establishment of schools for training men and officers for this branch of the service. Among other points, the standardisation of military side cars for carrying Lewis machine guns, and head lamp mounting lugs and brackets, the dimensions of magneto bases, and general dimensions for electric parts. A new military carrier [illegible] is suggested.

The Range of Electric Searchlights.—In an article in the "Electrical World," Lieut. S. G. H[illegible] gives some particulars of the range of electric searchlights. In general, owing to atmospheric absorption, it is impracticable to work at ranges exceeding 6,000 yds., although cases are on record in which ships have been distinguished at a distance of 9 miles, and on slightly misty nights the glare of distant beams may be seen in the sky at even greater distances. With a 60-in. mirror, an arc operating at 20,000 watts, the ranges at which targets of grey and medium light targets may be satisfactorily illuminated are stated to be as follows:—

Very clear atmosphere	10,000 yds. (or more)
Average atmosphere	6,000 yds. to 8,000 yds.
Slight haze or rain	3,000 yds. to 4,000 yds.
Fog or mist, dawn	1,000 yds. to 2,000 yds.

Royal Institution.—The following are among the lecture arrangements at the Royal Institution before Easter:—A course of six experimentally illustrated lectures by Professor J. A. Fleming, F.R.S., adapted to a juvenile auditory, on "Our Useful Servants: Magnetism and Electricity," beginning on Dec. 27; two lectures on the National Physical Laboratory, by Sir R. T. Glazebrook, F.R.S.; two lectures by Sir Napier Shaw, F.R.S., on illusions of the atmosphere: (1) "Revolving Fluid and the Weather Map," (2) "The Travelling Vortex and the Cyclonic Depression"; two lectures by Prof. W. J. Pope, on "The Chemical Action of Light"; six lectures by Sir J. J. Thomson, F.R.S., on "Problems in Atomic Structure." The Friday meetings will commence on January 18, when Professor Sir James Dewar will deliver a "Discourse on Studies on Liquid Films."

An Automatic Controller for Electrical Heating Apparatus. We notice in the "Electrical World" an account of a small and compact heating controller for use with electrical heating appliances, which has been brought out by the Automatic Electric Controller Co., of Seattle. The device is made in two types, one for alternating and one for both alternating and direct current. It consists of a thermostat, composed of copper and iron riveted together and placed immediately over a heating coil connected in series with the load. The heat from the coil causes the thermostat to break the circuit whenever the temperature rises above a certain point. It can be adjusted to operate over a wide range of temperature between 90 deg. and 160 deg. by causing the contact point to move downward and bend the thermostat, thus increasing the temperature requisite to cause the latter to break connection. It is claimed that the device will enable 40 per cent. of the heat now used in excess by various implements to be saved, as the exact temperature necessary for any operation can be obtained. The device also acts as a safeguard against excessive current.

The Inspection of Screw Gauges for Munitions of War.—Under the above title a useful pamphlet has been written by Mr. H. J. Bingham Powell, Inspector in Charge of the Department of Gauges and Standards, British Ministry of Munitions of War in the United States. The pamphlet is intended to assist gauge makers and manufacturers of munitions of war in standardising their own inspection arrangements, and has already been distributed to 150 such firms in the United States, and to various scientific societies and journals. The matter is divided into three sections, covering the following subjects: (1) The measurement of pitch; (2) the measurement of the full, effective and core diameters of the Whitworth thread, and of the full and effective diameters of the United States standard thread, of plug screw gauges and ring screw gauges; and (3) ring screw gauges. The tests applied are described in great detail, and the explanations are assisted by suitable illustrations, a recapitulation of the complete equipment necessary for gauge testing being finally given. We have no doubt that the pamphlet will be very useful to firms taking up work involving accurate measurements of all kinds.

The Minimum Radiation to Produce Visibility.—Of considerable interest, in connection with the perception of distant lights at sea and similar problems, is the minimum energy which the eye is capable of perceiving as visible light. Naturally this amount of energy will be found to vary according to the observer's sensitiveness of vision, his state of health and the previous history of the eye. Some experiments on this point by P. Reeves are summarised in a recent number of the "Astrophysical Journal," to which the matter is of interest in relation to the observation of distant stars. The experiments were conducted with an "artificial star," consisting of a pin-hole illuminated by light from an artificial source (presumably yielding approximately white light) the intensity of which could be dimmed to any desired extent by an arrangement of screens, neutral filters and absorbent wedges. Precautions were taken to keep the observer in complete darkness long enough for the eye to become adapted to faint lights, and the

area of the pupil was measured in each case. According to results with different observers minimum energy values, varying from $7 \cdot 7 \times 10^{-10}$; to $38 \cdot 9 \times 10^{-10}$; ergs per second were recorded. Admittedly the absolute minimum for the average person can only be determined very approximately.

Technics During and After the War.—We have received from Sir Robert Hadfield, F.R.S., a translation of an account of a recent discussion on the above subject, which appeared in a German paper during November, 1917. The discussion took place at the first general meeting of the "German Union of Technical Scientific Societies," formed by the combination of 13 associations and unions, representatives of the Imperial Government, the Federal Council and legislative bodies being present.

Herr Busley (the chairman) said that their object was to establish a balance between science and practice and promote collaboration between branches of science. An influence was also to be exerted on technical instruction and education and towards ensuring that the trained technician should be admitted to all administrative departments of the Federal States. The technical world ought to be represented more than was hitherto the case in the legislative bodies, and to be consulted in the preparatory work of drafting regulations or enactments.

Prof. Dr. Wiedenfeld (Halle) spoke on "Economics and Technics During and After the War," showing how in former days Germany could manage well with her own production, but subsequently became more and more dependent on foreign countries. Technical science could only meet the present requirements by disregarding the question of cost price. Substitutes were produced by calling in the aid of new modes of production, although not all of these new conditions and products can be carried over into the times of peace. Technical science aimed at: (1) Procuring the raw materials formerly obtained from abroad, partly by the re-establishment of industries which had become unremunerative (production of manganese, increase of the production of iron, production of sulphur, intensification of agriculture). (2) Promoting the tendency towards increased utilisation of waste products (*e.g.*, obtaining lubricants from coal tar, supplying requirements of clothing by utilisation of waste material, &c.). (3) Producing substitutes, such as, for instance, nitrogen from the air, and the production of substances by synthetic processes, where the natural way is no longer available, as, for instance, the cattle food produced from straw. The speaker recalled a dictum of his Excellency Fischer: "I cannot imagine any substance for which a substitute could not somehow be found." After the war they ought to aim at a reduced utilisation of certain raw materials. It would only be by strictly regulated syndicates that steadiness in the movement of prices could be established. The speaker concluded by attempting to lay down guiding principles for the collaboration of technical science and enterprise.

Industrial Reconstruction Council.—The first meeting of the Industrial Reconstruction Council was held on Tuesday afternoon at the Holborn Restaurant. The chair was occupied by the president, Sir Wilfred Stokes, K.B.E., and the draft constitution submitted by the Provisional Committee was approved and adopted. Among those present were Sir Herbert Bartlett, Bart., Mr. Ernest J. P. Benn, Mr. Walter Birch (National Furniture Manufacturers' Association), Mr. Emil Davies, Dr. William Garnett, Mr. A. McCallum Scott, M.P., Mr. Ben Tillett, M.P., and Miss Mona Wilson (Ministry of Reconstruction).

Mr. Ben Tillett, M.P., emphasised the need for a propagandist body, which would help to remove the [illegible] of labour and the [illegible] of capital. The need of the future was not [illegible] of labour, but efficiency of capital. He was glad to associate himself with a body which had for its object the [illegible] position of industry.

Mr. Ernest Benn, in presenting to the meeting the report of the Provisional Committee, [illegible] It was a propagandist body, and [illegible] Industry. Mr. Benn gave [illegible] of industry. [illegible] war [illegible] central [illegible] [illegible] chamber [illegible] interest. The membership of the Industrial Reconstruction Council was open to all [illegible] trial self-government. [illegible] campaign [illegible] awakening public interest in the vital problems of industry [illegible] together to take [illegible] industries.

Mr. Emil Davies, speaking of the Whitley Report, emphasised the fact that the Government had [illegible] down that labour [illegible]

There was a great need for some body like the Industrial Reconstruction Council, which would popularise the principles embodied in the report.

Miss Mona Wilson, as a member of the Whitley Committee, strongly supported the establishment of the Council as a propagandist body. It was extremely important that capital and labour should understand what a very wide field was open to the Whitley Councils if set up in all industries, and how necessary they were as representative bodies with whom the Government could negotiate in all matters affecting labour, commerce and industry.

Obituary.

EWING MATHESON.—The death is announced of Mr. Ewing Matheson, a well-known consulting engineer.

Mr. Matheson, who was born in 1839, was apprenticed to Messrs. Handyside & Co., of Derby, of which firm he subsequently became London agent and later a director. Later he formed the firm of Matheson & Grant, consulting engineers. In 1887 he accepted the position of managing director of the Farnley Iron Works Co. Mr. Matheson was the author of several books, including "Works in Iron" (1873), "Aid Book to Engineering Enterprise" and "The Depreciation of Factories." For some years he was an Alderman of the Leeds City Council, and in 1905 he was elected chairman of the Electricity Committee, an office which he held for three years, until that committee was amalgamated with the Tramways Committee, when he became vice-chairman. He retired from business in 1910.

DEATHS ON ACTIVE SERVICE.—The following deaths on active service are reported:—

Sec.-Lieut. R. C. Nudds (R.E.), who died of wounds on Nov. 30, aged 25, had served an apprenticeship with the British Westinghouse Co.

Pte. John Cameron, son of Mr. Angus Cameron, chief engineer to the Blackpool & Fleetwood Tramroad Co., is reported to have died in action.

Bombr. J. Cronin (R.F.A.), formerly a Burnley tramway employé, is reported to have been killed.

Pte. G. Hart (A. & S. Highlanders), a former employé of Dick, Kerr & Co., is reported to have died of wounds.

Personal.

Mr. E. J. Jennings, secretary and accountant of the Marylebone (London) Electric Supply Department, has been appointed secretary of the Birmingham Electric Supply Department, in succession to Mr. Howard Foulds.

WAR HONOURS.—The following honours have been conferred:—

Major A. W. Vignoles, borough electrical engineer of Grimsby, who has been on military service since the outbreak of the war, and who was recently awarded the D.S.O., has been promoted to lieut.-colonel.

Pte. F. Cotton (E. Lancashire Regiment), formerly employed in the Blackburn tramways department, and who was awarded the D.C.M. two years ago for conspicuous gallantry, has been given a commission in the Northumberland Fusiliers.

Corp. J. A. Barlow (M.G.C.) has been awarded the Military Medal. He was formerly engaged in the Stepney public lighting department.

Mr. A. A. Preston, formerly district superintendent of the electrical department of the Soudan Government Railways at Port Said, has been given a commission in the Egyptian Labour Corps.

Capt. R. M. C. Charley (R.F.C.), aged 25, has been recommended for the Military Cross. He was formerly employed at the British Westinghouse Co.'s works, Trafford Park, and subsequently at the Westinghouse works, Pittsburgh, Pa.

Sergt. Nuttall, a former employé of Grimsby electricity department, has been awarded the Military Medal.

WAR CASUALTIES.—The following casualties are reported:

Sec.-Lieut. C. A. Robertson (8th Manchester Regiment), son of Mr. J. A. Robertson, [illegible] He was [illegible] the British Westinghouse Co.

Capt. [illegible] (South Lancashire Regiment), formerly chief [illegible] to the Blackpool & Fleetwood [illegible] reported [illegible].

Arrangements for the Week.

FRIDAY, Dec. 21st (to day).

[illegible]

THURSDAY, Dec. 27th.

[illegible]

SATURDAY, Dec. 29th.

[illegible]

Conveyors and Elevators.

By W. H. ATHERTON, M.Sc., M.I.Mech.E.

(Concluded from p. 433.)

Summary.—The development of the conveyor and elevator for the handling of coal is first outlined, and then the various requirements are considered in detail. Sufficient coal storage is a vital matter for the power station, and introduces problems which are conveniently solved by conveyors. The various types of conveyors and elevators for coal handling and ash handling are considered in some detail, and reference is also made to the suction method of removing ashes.

As there is no rigid limit to the width of band conveyors it is quite feasible to make them of very large capacity, viz., 500 tons or more per hour. But a belt 36 in. wide running at the moderate speed of 250 ft. per minute will easily handle coal at the rate of 100 tons per hour, and it is seldom necessary to exceed this capacity.

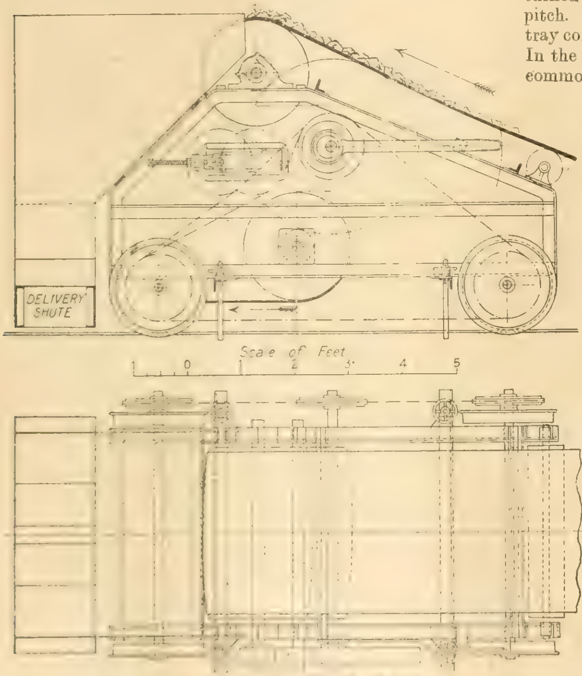

Fig. 15.—Throw-off Carriage for 36 in. Band Conveyor

Fig. 16 shows a short inclined band conveyor made for a colliery to handle 120 tons of small coal per hour at 300 ft. per minute. Fig. 17 is a section of the supporting rollers.

Another form of conveyor very suitable for taking coal from coal stores is the tray or pan conveyor. This type of conveyor consists of a series of overlapping pressed steel trays with turned up sides, bolted to an endless chain usually of 12 in. pitch. Fig. 18 is a clear view of the central part of a tray conveyor, drawn exactly to scale in isometric perspective. In the design shown, travelling rollers revolve on axles, but a common design is to have supporting rollers of large diameter

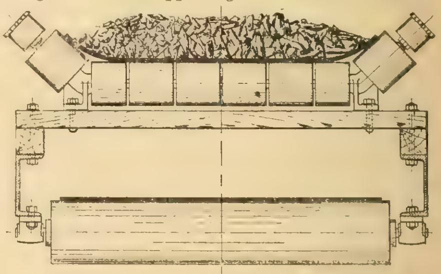

Fig. 17.—Details of Supporting Rollers.

and shafts revolving in fixed bearings. Sometimes two strands of chain are used, but a single heavy chain is more durable than two strands of lighter chain. There is seldom any need to adopt two strands of chain, unless the width of the tray exceeds, say, 24 in.

The tray conveyor is a very useful means of carrying either large or small coal and other minerals. It has also been successfully applied for handling ashes and clinker. Although tray conveyors need

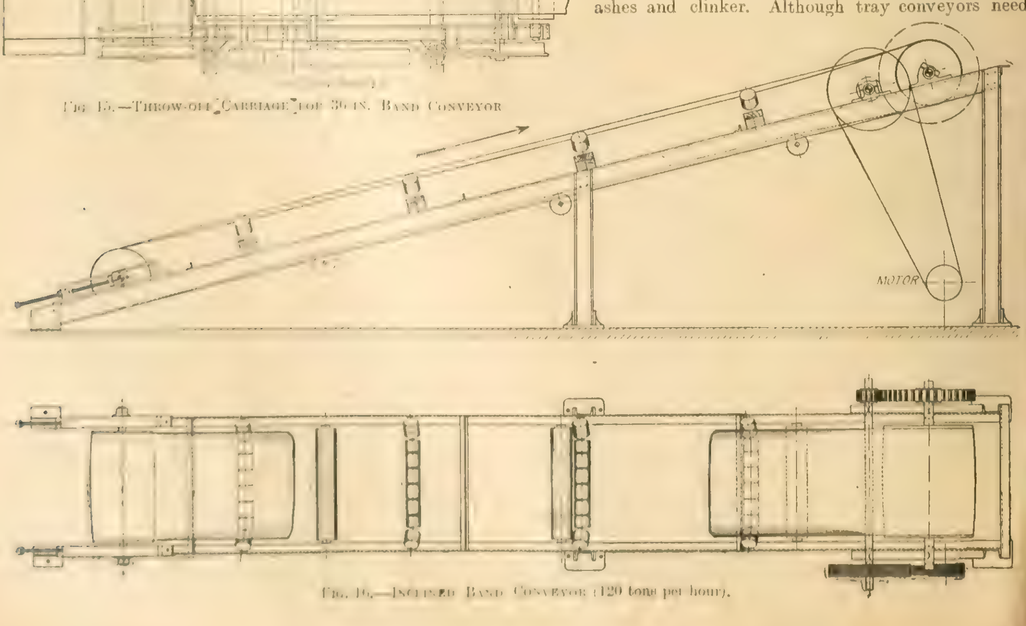

Fig. 16.—Inclined Band Conveyor (120 tons per hour).

not be horizontal, the trays must have cross pieces or backs to prevent the material sliding down, if the inclination exceeds about 20 deg. The tray conveyor then develops naturally into the continuous bucket elevator, as shown in Fig. 19, in which the buckets overlap instead of having an interval between them, as in the ordinary dredging bucket elevator. A good inclination for a continuous bucket elevator is from 60 deg. to 70 deg. to the horizontal. This type works well with lumpy coal and cutting materials, such as ashes or clinker. An ordinary speed is about 80 ft. per minute, but the slower the speed the greater the durability.

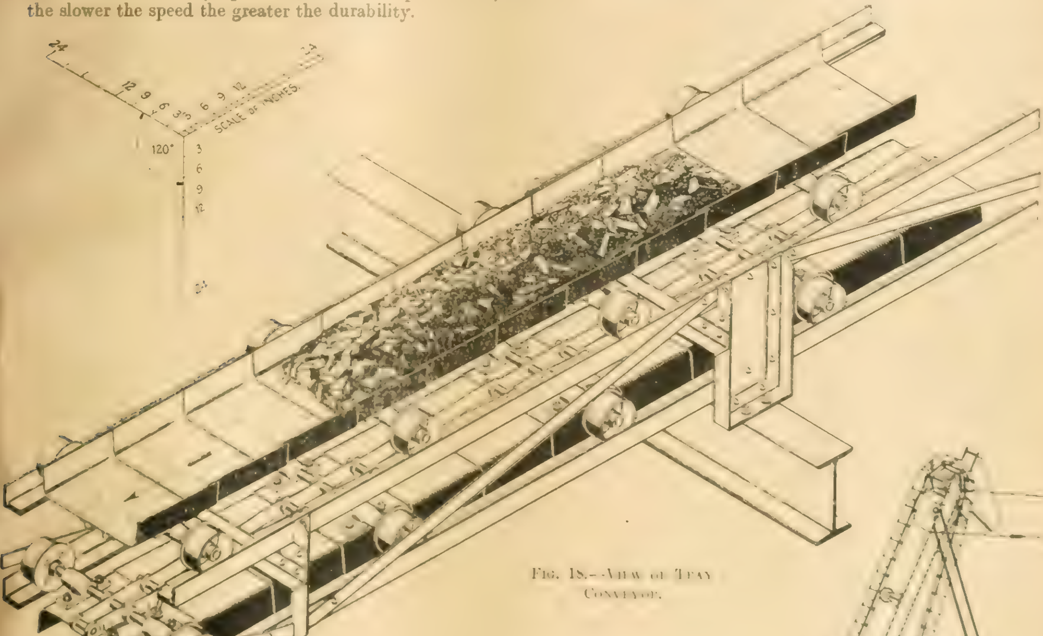

FIG. 18.—VIEW OF TRAY CONVEYOR.

GRAVITY BUCKET CONVEYORS.

A gravity bucket conveyor consists of a pair of endless chains running over suitable driving and corner wheels, and carrying a continuous series of buckets which can swing freely on trunnions instead of being rigidly fixed to the chains. (*See* Fig. 20.)

The characteristic feature of this type of conveyor is that the centre of gravity of the full buckets must always remain below the axis of suspension, thus enabling the chains to travel horizontally, vertically or inclined at any angle without the buckets spilling. Each bucket is really a little tipping truck or car mounted on two flanged wheels about 5 in. diameter. Motion of the buckets in two vertical planes at right angles to one another is not feasible, however, in the ordinary type of gravity bucket conveyor, though attempts have been made to overcome the limitation of motion in one plane only on special types of conveyors which have not yet passed beyond trials [illegible].

The common arrangement of gravity bucket conveyors is that indicated in Fig. 21, where the conveyor buckets run through a tunnel below the boiler house floor, and can be used for lifting ashes into an elevated bunker, as well as for handling coal. An alternative arrangement is represented in Fig. 22, the latter requiring less excavation and being preferable where ashes are handled by a separate conveyor.

For emptying the buckets a series of fixed tripping devices or tippers are placed under the required points of discharge, one simple form of tripper being shown in Fig. 23. These trippers meet projecting cams on the ends of the buckets, which tip the latter through 90 deg. in order to discharge their contents, after which the buckets swing about for a few seconds before resuming the horizontal position. The speed of the buckets should not exceed 50 ft. per minute, while a slower speed is conducive to quiet running and durability.

For filling the buckets a rotary filler is placed between the feed hopper and the conveyor at the end of the lower run. This delivers a measured quantity of small into each bucket, and prevents spilling between the buckets. One form of filler is shown in Fig. 24, this being driven by a chain from one of the

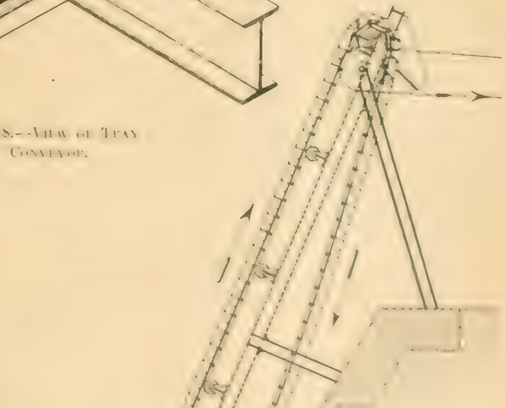

FIG. 19.—CONTINUOUS BUCKET ELEVATOR.

power shafts. Another form of filler is shown in Fig. 25, which is more effective for larger coal. This may be driven by fixing a large sprocket wheel on the filler shaft and gearing the wheel into the main conveyor chains, or it may be driven by a separate drive from a power shaft.

Many buckets are made of pressed steel in one piece, with the cams of malleable iron riveted on; others are made in malleable iron with the cams cast on. The particular bucket shown in Fig. 20 is a composite bucket having malleable iron ends, with a steel plate body riveted to the ends; this design having the practical convenience of enabling the same ends to be utilised for buckets of different widths by simply varying the widths of the plates.

In this country most gravity bucket conveyors are fitted

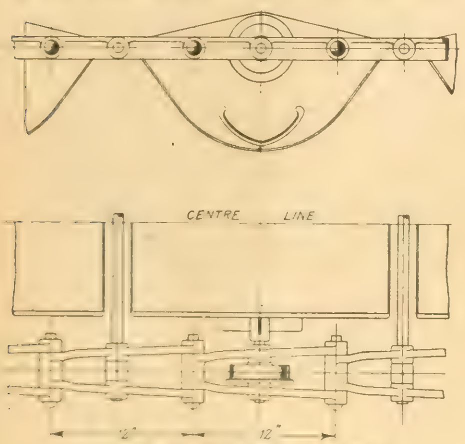

Fig. 20.—Gravity Bucket Conveyor.

with flat link steel chains, but the malleable iron chain shown in Fig. 20 is also successfully employed, every link being alike and cast in one piece. The large bearing area is conducive to durability. The two strands of chain are connected by cross-stays between the buckets, which keep the gauge constant.

In America various types of tipping bucket conveyors with overlapping buckets are largely used. For handling lumpy materials these are better than the ordinary type with a gap between the buckets, because they can be fed at any point on the horizontal run by an ordinary chute or by a jigging feeder.

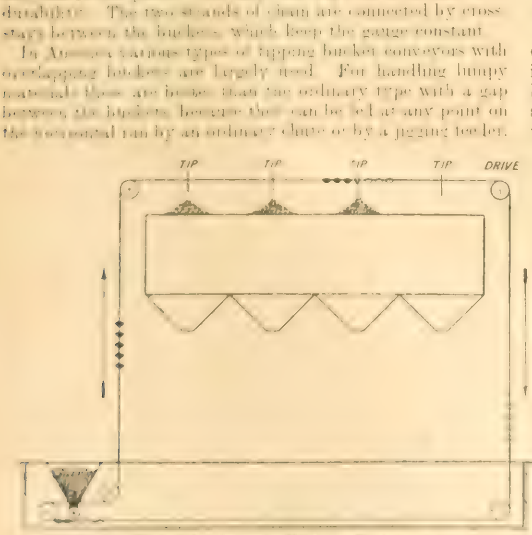

Fig. 21.—[illegible]

[illegible]

Ash Handling Plant.

[illegible]

much more troublesome to handle than coal, because of their cutting and destructive properties. One method of working is to utilise a gravity bucket conveyor, at those intervals of time when it is not engaged in lifting coal, for the purpose of raising the ashes from the ash tunnel into an overhead bunker, from which they can be discharged into carts, motor trucks or railway wagons. The bunker may be constructed of steel plates riveted together, cast-iron plates bolted together, or of ferro-concrete.

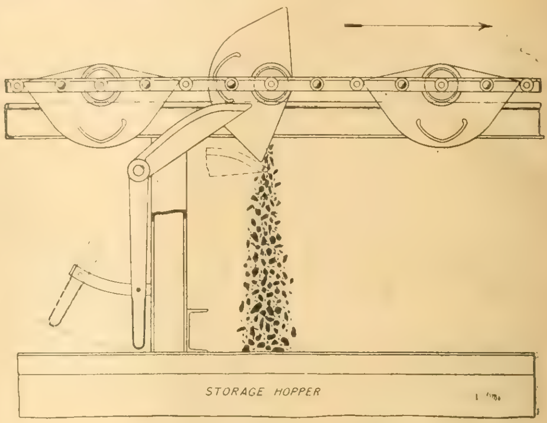

Fig. 23.—Details of Tripper.

A second method of dealing with ashes is to erect a separate conveyor of the overlapping tray type in the ash tunnel, delivering into a steel plate skip outside the boiler house, which can be lifted when full by a crane, and the contents dumped into a motor truck.

A third method is to wheel the ashes in iron barrows to a convenient point, and tip the contents into the boot of an inclined elevator, preferably of the continuous overlapping bucket type, which lifts the ashes into an overhead cast-iron storage hopper, fixed high enough to allow a steam lorry with tipping body to run below it. Fig. 26 shows an actual plant

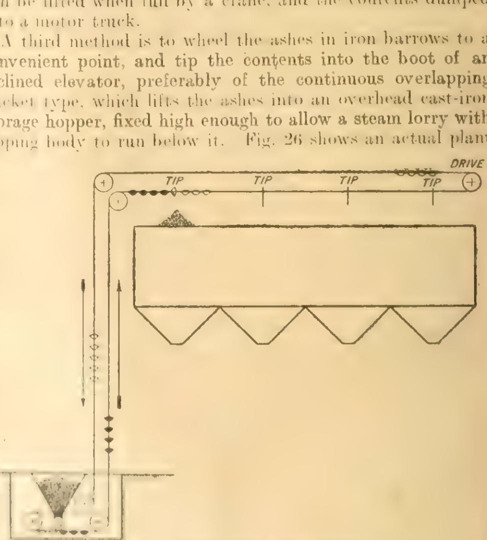

Fig. 22.—Alternative Arrangement.

recently erected to deal with the ashes and refuse from a large foundry.

By operating a suitable discharge valve at the bottom of the hopper a [illegible]-ton lorry can be loaded up from the storage hopper, and can be got away in a few minutes. The steam lorry will get rid of its load at the nearest public or private tip, a disused brickyard or clay pit often being utilised. The body of the truck can be rapidly tipped by power, using a hydraulic cylinder operated by a pump instead of by screw gear; the latter

being considerably slower. A motor lorry thus equipped with power driven tipping gear can work very efficiently and make a large number of journeys per day between the power station and the tip. It is equally useful in other works, such as foundries and steelworks, where large quantities of spent sand, ashes, furnace clinker, slag, and other rubbish have to be disposed of daily. The old way of loading trucks by hand shovels is too slow and costly to be tolerated nowadays, besides being extremely dusty and unpleasant. In country districts a wire ropeway can sometimes be adopted for taking the ashes from the boiler house to a refuse dump or spoil heap situated a considerable distance away, as an alternative to a motor lorry.

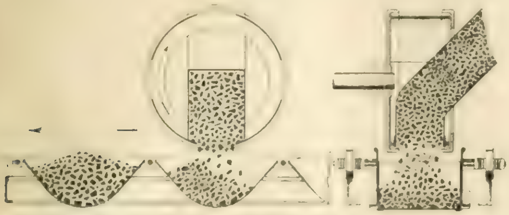

FIG. 24.—ROTARY FILLER.

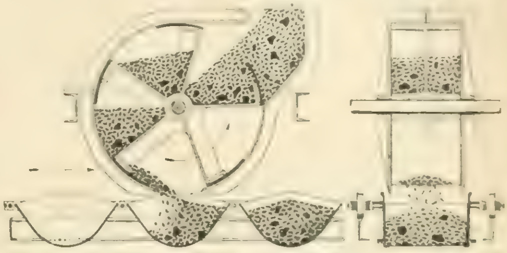

FIG. 25.—ROTARY FILLER.

The continuous bucket type of elevator is more suitable for raising large quantities of ashes than the ordinary type of dredging elevator, on account of the chain being better protected and the destructive dredging action being avoided.

Another type of elevator, known as the skip hoist working intermittently, is also a useful machine which deserves to be better known. The general arrangement of a skip hoist for handling ashes, clinker and rubbish generally is shown in Fig. 27. Instead of a series of small buckets bolted to a continuous chain, there is a single large bucket or skip having a

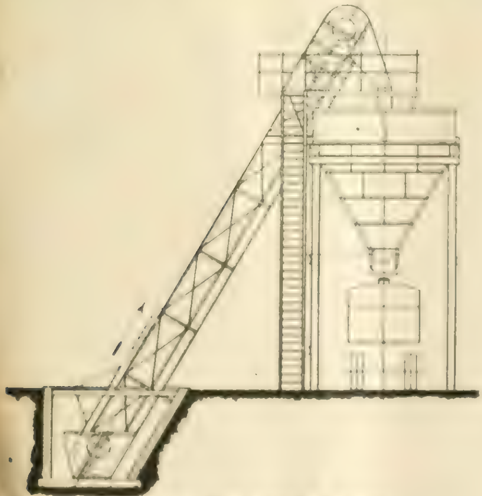

FIG. 26.—ASH HANDLING [illegible].

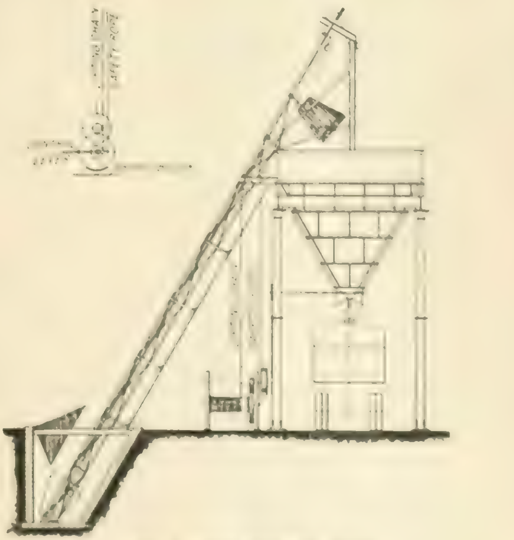

FIG. 27.—SKIP HOIST FOR ASHES.

capacity of about [illegible]. The skip is provided with four small flanged wheels running on two tracks which diverge at the top so that when the skip is in its highest position it is automatically tipped. When in its lowest position the skip is filled from a small hopper [illegible] which receives the ashes from [illegible]. When the skip is full the hoisting gear is operated by lifting a control lever, which puts into gear the friction wheels of the power-driven hoisting crab, and the skip climbs upwards. At the point of discharge the skip automatically throws the friction wheels out of gear by lifting the safety rope, thus preventing over-winding. The skip is held securely in its top position by the large friction wheel being dropped into contact with the brake block. The safety rope connects a rocking lever at the top of the hoist with the shorter arm of the control lever on the crab.

During the descent of the skip by gravity the control lever is held in mid-position—*i.e.*, with the friction wheel running free of both pinion and brake block. The motion of the skip is checked as it is nearing the bottom by releasing the control lever, thus putting the friction brake in gear. The crab may be driven by an electric motor or by a steam engine, or by shafting or any other convenient source of power.

Either hot or cold ashes and lumps of clinker can be raised by a skip hoist, and a point in its favour is that the lifting chain is not exposed to the action of the ashes. It is advisable to limit the size of clinker to something like a foot cube, otherwise there would be difficulty in discharging large lumps from a concrete hopper. [illegible]

[illegible] belt bucket elevator of the type shown in Fig. 28. The elevator is [illegible]

current through a flexible cable or by a petrol engine. The elevator is self-propelled at a slow-speed, or it can be arranged to be moved about a yard by a horse or a motor lorry.

stack. In order to minimise the excessive wear or erosion at the pipe bends due to the impact of the dust, ashes and clinker, the bends should be of large radius and provided with renewable liners.

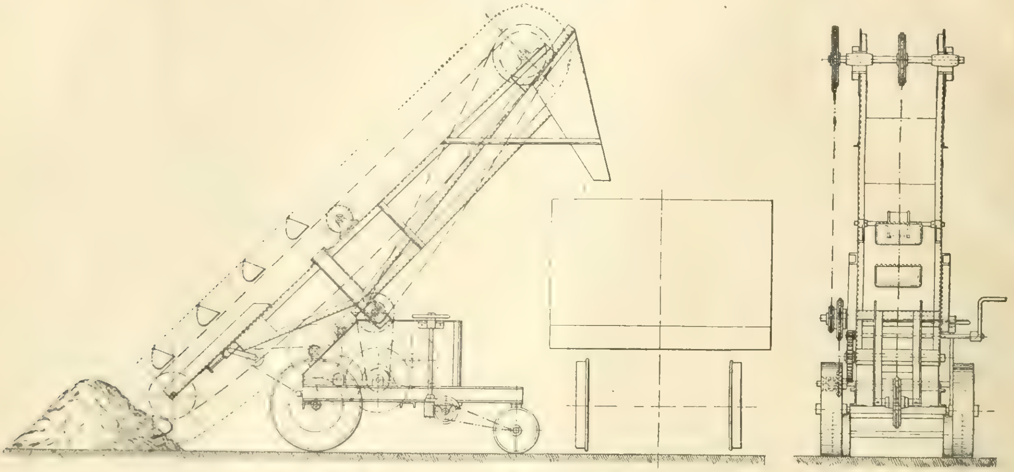

FIG. 28.—ARRANGMENT OF PORTABLE ELEVATOR.

SUCTION ASH CONVEYING PLANT.

About the year 1897 a very flexible method of unloading grain from ships by means of pneumatic or air-suction plant was introduced. This plant consisted of a rotary exhauster, or a vacuum pump, connected by a system of flexible pipes and suction nozzle to the ship's hold and to an elevated receiver or vacuum tank fitted with an air lock for discharging the grain. In this method a partial vacuum is created in the pipes by the exhauster, and the superior external atmospheric pressure then forces the grain through the suction nozzle and flexible pipes into the receiver. There is some similarity in principle and mechanism between this method of removing grain from ships and the method often adopted of removing dust from carpets in large hotels. The vacuum carried in the receiver is about 10 in. of mercury.

Of recent years the air suction principle has also been applied to the conveyance of dust, ashes and small clinker in boiler houses. It is very wasteful of power, but has some compensating advantages. The method is convenient for collecting the material from various points to one central storage bin with a minimum of labour. Of course large lumps of clinker cannot be handled by this means, but pieces of clinker up to [illegible] can be drawn through the suction pipe. Should the clinker formed be of a friable nature, a breaker for reducing the clinker to a small size, though not essential, is convenient and desirable, because even when the clinker is friable a breaker deals automatically with occasional lumps, and it also regulates to some extent the flow of the clinker into the suction pipe. In comparison with the power required to maintain the vacuum in the system, the power absorbed by the clinker breaker is not great, but at least [illegible] should be provided for this purpose.

In installations where there is an underground ash cellar [illegible] may be fitted at the inlet of the pipe into the receiver to keep down the dust. The air passes from the top of the receiver to the exhauster, and thence may be led into the main chimney

An incidental advantage of the pneumatic system of conveying ashes is its utility in minimising dust, the large quantities of dusty air drawn into the suction pipe assisting to keep the ash cellar clean and well ventilated.

Cyclic Candle-power Change with Alternating Current.*

By D. L. MARKLE.

At the Pennsylvania State College a method was recently devised whereby the change in the candle-power of the filament during a cycle of alternating E.M.F. could be measured.

This method is an adaptation of the step-by-step method of tracing alternating current wave forms to photometric measurements. The only special apparatus used is a small synchronous motor to drive the sectored discs generally found among the accessories of any standard photometric equipment.

The sectored discs were fastened to the shaft of the synchronous motor by means of a face plate and thumb nut. The pointer attached to the face plate is set opposite a circular scale concentric with the discs. This scale was laid off in divisions corresponding to 10 electrical degrees on the voltage wave.

The apparatus was mounted on the photometer bar directly in front of the lamp under test, and the motor was operated on the same alternating current circuit to which the test lamp was connected. Then, with the pointer set to an arbitrarily chosen zero or starting point on the circular scale, the motor was brought up to speed and synchronised with the lamp circuit, and photometric readings were taken. The motor was then stopped, and the discs were rotated on the motor shaft through an arc equivalent to 10 electrical degrees on the voltage wave, after which the motor was again synchronised and photometric observations were made. This procedure was followed until the discs had made one complete turn on the shaft of the motor.

It is evident that the filament of the lamp will be exposed to the photometer screen during successive intervals of time whose length depends upon the disc opening. It is also evident that with the same number of disc openings as there are poles on the rotor the filament will be exposed to the screen during similar intervals and at similar positions on both positive and negative loops of the voltage wave.

In the case examined the candle-power values were obtained with a disc opening of approximately one thirty-sixth the total disc area, and are, therefore, average values for portions of the voltage wave corresponding to 10 electrical degrees. No attempt has been made up to the present time to obtain simultaneous values of voltage and candle-power to determine whether the maximum values of candle-power occur simultaneously with the maximum values of voltage.

* Abstract of an article in the "Electrical World."

The Metric System.

Last week a discussion upon the metric system was held at the Institution of Electrical Engineers. The object was to determine whether the adoption of this system would be to the advantage of the electrical industry, and it was opened by Papers, which we give below, by Mr. L. B. Atkinson and Mr. A. J. Stubbs.

THE "PROS AND CONS" OF THE METRIC SYSTEM.*

BY LLEWELYN B. ATKINSON.

INTRODUCTORY.

For the past 30 years there has been a discussion proceeding as to whether Great Britain should adopt the Metric System of Weights and Measures. This Paper is an endeavour to define clearly the real issues that are the subject matter of such a discussion.

THE QUESTIONS AT ISSUE.

The points at issue may be summarised as follows:

1. *The question of the decimalisation of moneys, weights and measures*, that is: (a) Is a system of moneys or weights or measures, in which the successive magnitudes are multiples of 10, better than a system in which other multiplying factors are used? (b) If so, is the metric system of weights and measures (which is a decimal system) the best system to adopt, and what monetary system should be adopted?

2. *The question of the actual magnitudes involved*, that is: Are the metre, the kilogram, and the litre, with their multiples and sub-multiples, better than the yard, the pound, and the gallon, with their multiples and sub-divisions, either absolutely, or because of their arithmetical relations?

3. *The question of policy*. (a) Is it so desirable to have a universal world-wide system that even at the risk of not having the best system, we should adopt a system which would then become universal? (b) If so, is it good business at the particular moment to adopt a system with which our enemies are more familiar than we are?

Leaving the coinage question for the moment, the systems of weights and measures which are under discussion, are as follows: The British System, the Metric System, and the C.G.S. or Absolute System.

The three systems named above being defined as to their legal standards, it becomes necessary owing to the range of sizes which have to be measured, to have multiples or sub-multiples of these units.

It is customary in schools and works of reference in setting out tables showing the multiples and sub-multiples, to include a very large number of measures which relate only to specific trades or goods, and which are, in fact, never used except by a comparatively small number of people dealing in particular products. In the case of the C.G.S. or Absolute System, [illegible] and it remains to consult books of reference to find out what are the multiples that are ordinarily being used, [illegible] by a figure multiplied by a power of 10. In the original Paper the author therefore sets out tables of multiples and sub-multiples of the units in the [illegible] systems, which really are the multiples with which trade, commerce, and [illegible] work, are carried on.

As has already been indicated, there are [illegible] British measures which are related to the British tables, but they are not in general use and may be regarded [illegible] practical fact. [illegible]

The questions which were set out early in this Paper must now be dealt with.

[illegible]

[illegible]

[illegible]

perform additions, there is no question but that measures which proceed by multiples of 10, following our decimal system of arithmetic, are superior to any others. On the other hand, that at least 90 per cent. of the people of any country do not use any of these aids to calculation, and they perform their calculations by mental arithmetic or by ready reckoners. It is then simpler to have a variety of units connected together by such short intervals as 2 and 4 and other multiples of 2, enabling mental arithmetic to be performed very easily. We have, therefore, to decide whether it is more important to cater for a large mass of people of moderate ability who work by mental arithmetic, or whether it is better to cater for those of a higher scale of ability and able to use aids to calculation.

QUESTION OF THE ACTUAL MAGNITUDES INVOLVED.

Some words may now be said on the actual merits for general and engineering purposes of the units existing in the various systems. So far as ordinary trading and domestic purposes are concerned, the pound and the half-kilo weight are the weights best suited for the mass of the population, the kilogram being too heavy for a general standard. For wholesale purposes the ton, or 1,000 kilograms are units of a right magnitude, whilst the weight of about 1 cwt. or 112 lb. (say 50 kilos) is another weight which is more useful than 100 kilos because it happen to be about the maximum weight that a man can conveniently handle.

For measures of length there is obviously nothing to choose between a metre and a yard, whilst the foot is an exceedingly useful dimension. For general purposes probably a centimetre is more useful, needing less sub-dividing, than the inch, but on the other hand the 1/16 inch, which is the smallest measure used in general work, is better than 1 millimetre, which is too small. In engineering the 1/100 and 1/1,000 of an inch are generally considered to be more useful than the millimetre and the tenth of a millimetre. Thus so far as the actual magnitudes are concerned the balance of advantage seems to lie with the British standards of length.

As to measures of volume, there is not a great deal to choose, the ½ pint, which is a common measure, is not far from the ¼ litre. One gallon and five litres being of the same order of magnitude are both readily expressible. The metri system presents the advantage of having the unit of volume also a direct multiple of the unit of length. This latter advantage, however, only appeals to engineers and scientific people, because ordinary people do not know how to perform calculations based on specific gravity.

On the questions therefore of absolute magnitude there seems to be no strong reason for advocating or for opposing a change in the standards.

THE QUESTION OF POLICY.

It is conceded by all parties that it is desirable that a universal system of weights and measures should be adopted by all nations; and the only question is whether the British system is better. The vast bulk of the people of a country are never consciously affected by the weights and measures of another country; it is the merchants [illegible]

[illegible]

[illegible]

[illegible]

the question of the metric or other universal system of weights and measures. A single international gold money standard is of no use, and decimalising the currency is therefore largely one of the convenience of the particular country concerned. The principal discussion really hinges on whether 12 as the base of the small denomination has great advantages over 10.

CONSIDERATIONS AFFECTING THE PROCEDURE TO BE ADOPTED IF IT SHOULD BE DECIDED TO ADOPT DECIMAL COINAGE AND METRIC MEASUREMENTS IN THE UNITED KINGDOM.

Under this heading the author proceeds to consider the measures which could be adopted for a change of system, and the following is put forward as a practicable and possible programme :—

1. Legalise and enforce decimalised currency.
2. Obtain an alteration in the standard pound and gallon, making them in fact direct multiples of the kilogram and litre.
3. Start an educational campaign based on improving the general standard of education so that a complete decimalised system could be brought into force and made compulsory, because it could be used by the people who have to use it.
4. And subsequently put in force compulsorily the metric system of weights and measures of capacity by merely changing the names and abolishing the multiples based on the factor 2.
5. Finally put in force compulsorily the metric system of lengths, which will by that time have become largely used.

A Bill for the acceptance of Parliament would require detailed consideration.

There are hundreds of legal enactments which fix the price of tolls, railway rates, dock dues, charges for water, for gas, for electricity, for cabs, trains, buses, for stamps and fees, for sales of goods, forms, &c. Each of these has to be hunted up and scheduled ; for each of these a proposal has to be made, and if possible agreed before the House of Commons is reached.

As the same process will have to be gone through again if the metric measures of weight, volume, and length come into force, it certainly would be desirable at least to make the change in the lb. and gallon herein suggested, at the same time as the coinage is decimalised.

A CASE FOR THE ADOPTION OF THE METRIC SYSTEM (AND DECIMAL COINAGE) BY GREAT BRITAIN.*

BY [illegible]

I. THE METRIC SYSTEM.

[illegible] The germ of the metric system was [illegible] by James Watt, in a letter [illegible] in 1783. Rather less than 130 years ago the French developed the idea into a very complete [illegible] at the time of the Revolution. The metric system [illegible] the metric system as originally proposed.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

The lb. troy is less than the lb. avoirdupois, but the oz. troy is greater than the oz. avoirdupois. This anomaly, however, has recently been abolished by the expedient of making the ounce the only troy weight unit.

Another example of the system of chaos is afforded by our land measure. If one wants to set out a square of exactly one acre one can do so by making the side of the square the convenient length of rather less than 69·58 yards. Of course in the metric measures the length of the side of a square hectare is a hectometre and of a square kilometre is a kilometre, just as with us the length of side of a square yard is a yard.

Those who object to the adoption of the metric system often refer to alternatives.

Now, I submit that there are only two possible courses open to the British people in this 20th century.

We can retain the British tables or we can adopt the metric tables. To talk about a duodecimal system, for instance, is only to waste words. It has not the remotest chance of securing the adhesion of mankind. The only practical way of mending our present system is to end it.

II. ADVANTAGES OF THE METRIC SYSTEM.

(*a*) *Scientific Basis.*—The benefit of the metric system being on a scientific basis appeals to electrical engineers.

By universal consent all relations of weight are based upon the weight of a unit mass of pure water at its maximum density. Thus, for example, the specific gravity of water is taken as unity and all other materials are related to it by reference to the weight of equal mass. As a cubic foot of water weighs 62·288 lb., the weight of a cubic foot of any other material may be ascertained by multiplying its known specific gravity by 62·288 lb. Under the metric system as 1 cubic decimetre of pure water weighs 1 kilogram, the weight in kilograms of any other material is represented by its specific gravity without calculation. So with other ratios of everyday use.

(*b*) *Simplification of Calculations.*—The scientific basis of the metric system conduces to consiseness of conception, but the simplification of all ordinary calculations is almost beyond expression.

Under the head of simplification I think it is fair to put engineering drawings. What a mixture of dimensions we get now. Even where restricted to English measures we get feet, inches, and quarters, eighths, sixteenths, thirty-seconds, sixty-fourths, and mils. Under the metric system every dimension, large or small, can be expressed in millimetres and automatically translated when the higher unit needs to be expressed.

(*c*) *Mechanical Calculator.*—Again, with the metric system clerks and accountants would find that in all calculations the ordinary decimal calculator, or even the slide rule, will give all the results required.

(*d*) *Education.*—Of 221 head masters who reported upon the subject in 1903, 212 expressed unreserved support of the metric system, as its introduction was estimated greatly to economise school life, 161 masters estimated the time at 1 year, 30 masters estimated the time at 2 years, and 6 masters estimated the time at 3 years.

(*e*) *Internationalisation.*—The inconvenience of want of uniformity of international measures has been impressed even upon the "man in the street" during the war.

This inconvenience is enormous to engineers and others who have constantly to deal with works of foreign and of American authorship.

With almost every kind of ironwork, some dimensions are expressed in feet and some in inches, or even in special gauge numbers.

Scientists, whose work is international, are practically compelled to express their results in international terms, even if they also use the English measures.

III. DISADVANTAGES OF A CHANGE OF SYSTEM.

(*a*) *General.*—1. *English Measures well Known.*—That there are appreciable advantages presented by continuance of the present [illegible] cannot be questioned. Our measures have come to be known by merchants of all nations and in many cases our practice [illegible] practically international.

2. Again, the unit of capacity of a ship is the ton-register, equal to 100 English cub. ft., although the ton measurement of cargo is only [illegible]. Yet this typically British rule of thumb unit is still [illegible] acceptance, even by the metric countries.

Whatever advantages, however, may be admitted in the British [illegible] continued use shuts us off from any advantages that may be presented by a truly international system.

(*b*) *Cost.*—1. *General.*—The objection to the change that has to be [illegible] perhaps the matter of the cost involved in making the change. This would, however, be borne in relatively [illegible] according to the turnover. Progressive

retailers during the last few years have "scrapped" not only their weights but their scales in favour of direct reading balances. Those balances could be corrected to the new weights for a relatively very small sum.

2. *Engineering work.*—Similarly with a big engineering firm, the cost of the change for templates, gauges, meters, dies, &c., will for the most part only precipitate normal renewal, and will be a mere decimal point of the regular expenditure under many overhead charges, such as postage.

3. *Estimates. Taring of Railway Trucks.*—A great railway engineer recently showed how the comparatively simple process of re-taring all the railway trucks would cost about £400,000. But railway trucks are re-tared normally when they come into the shops for repair, so that this would appear to be quite a minor matter.

Shipbuilding.—In 1895 the president of the North-East Coast Institution of Engineers and Shipbuilders, when advising the then Prime Minister (Mr. Balfour) that his members were unanimously in favour of the change, stated that at his own works with a wages bill of £2,500 a week the cost of the change would be little over £100.

4. *Effects on Existing Plant.*—There would not be the slightest need to alter the dimensions of machines—toolmakers might even continue for years to make $3\frac{1}{2}$-in. lathes if they wished.

It must not be understood, however, that generally using the present measurements and giving them metric nomenclature is adoption of the metric system. We should ultimately use round figures in the metric system as we do in the English and should, for example, not stock 1-in. rod and call it 2·55 mm. but should have 25 mm. rod as the standard item.

(c) *Loss of Mental and Manual Facility Habits.*—One aspect of the change that perhaps more even than the cost will be felt to bear hardly upon the individual is the loss of expertness and facility that is bound up with the existing practice.

Most people, however, will readily adapt themselves to the new conditions, and for those who cannot, facilities will exist.

(d) *Dual Stocks.*—Of course in commerce during the transition stage the two things themselves would actually exist; at first the stock of $\frac{1}{2}$-in. bolts would predominate, and at last only the 12-mm. bolts would be obtainable except as a special order. For many a long day we should continue to think of distances in miles, but when we had to pay in kilometres we should gradually get to think in kilometres.

(e) *Difficulty of Working in Decimals.*—It is a little perplexing to know how best to counter this objection, because so many opponents of the metric system contend that it would be better to decimalise the English weights and measures. But really the difficulty has already been overcome. The English mechanic is quite used to working to mils, i.e., ·0001 in., and occasionally carries the division to the fourth place as 0·0001 in.

(f) *Correction of Drawings.*—For the most part there need be no correction. At present in works and drawing offices where a few drawings to metric scales are handled, no confusion results. How much less would drawings to the familiar scales need special treatment in the transition stage. But really the references to old drawings are not very considerable.

IV. Conditions of Introduction.

Some appreciable inconvenience will have to be faced by the community when the transition from English to metric measures begins, but this would be less in the immediate future than at any later time. Our existing standards have already been rudely disturbed.

Further, great masses of our men who will be returning from France will be to a limited extent familiarised with the French coins and metric measures.

As regards the question of compensation it is hardly unpracticable otherwise to carry out any reform which affects the property and interests of various sections of the community.

V. Decimal Coinage.

(a) *Lowest Decimal System.*—Although the subject of coinage is very closely associated with that of weights and measures the two are really quite distinct and are capable of separate treatment.

The Institute of Bankers this year adopted the report of a committee appointed to consider the whole subject, which recommended the introduction of a decimal system having as its [illegible] [illegible] standard with one pound as the unit. The pound would be divided into 1,000 mils, [illegible] [illegible] [illegible] coins designated to [illegible] of lower value.

This scheme presents the advantage of [illegible] a change [illegible] of coins that cannot well be confused with any other system. It involves no break with the [illegible] of British [illegible] maintains both gold and silver coins at existing values, and necessitates only a 4 per cent. variation in the value of the bronze coins.

Replacing standard weights of retail traders would be a fairly considerable matter. It might be better to let local authorities decide within a time limit the date of introduction in their several districts—the only restriction being that in every shop during the transition period there should be only one system of measures used, and that the actual system in use should be prominently notified. For example, if the Act provided that on and after (e.g.) Jan. 1, 1919, all transactions should be carried through on the metric system, on and after that date in every shop there would be exhibited, besides suitable conversion tables, a notice that "Scales, Weights, and Measures used are Old Style," or "Scales, Weights, and Measures used are Metric."

Therefore the local authority would notify that on and after (say) March 31, 1919, all scales, weights, and measures used in dealing with the public must be on the metric system.

There can be no doubt that every year that we delay adopting it the difficulty and the expense of introducing the system are increased. Therefore the logical and reasonable procedure, with proviso that due time be allowed for the necessary preparations, is DO IT NOW.

An account of the discussion will appear in our next issue.

Heat Engines.

In the Thomas Hawksley lecture before the Institution of Mechanical Engineers on November 30, Capt. H. Riall Sankey, C.B., R.E., detailed the history of various forms of prime movers. The prevailing commercial custom with the steam engine to state the number of pounds of steam per indicated horse-power or brake horse-power hour or kilowatt-hour led to serious error in the case of engines running with superheated steam and was contrary to the recommendation of the Committee on Engine and Boiler Trials of the Institution of Civil Engineers in 1897, which adopted the theory of equivalent feed. This was expressed as follows:—

$$\text{Equivalent feed} = \text{actual feed} \times \frac{\text{heat required per pound of steam}}{1{,}000}$$

With low degrees of superheat the error was not very great, but with high degrees of superheat the error was considerable. For instance, in a test on a battery of steam turbines of 200 [illegible] running at 3,000 revs. per min., steam pressure 195 lb., superheat 200 F. and vacuum 28·7 in., the steam consumption given in the ordinary way was 8·5 lb. per brake horse-power, but according to the equivalent feed formula it was 9·6 lb., an error of 11·5 per cent. In a second case there was an error of 28 per cent. Therefore, the heat economy of steam engines should be quoted in terms of equivalent feed, or preferably in the number of B.Th.U.'s required to produce 1 [illegible] hour.

[illegible] would do away even with this, and it might be anticipated that the [illegible]

[illegible] the war.

[illegible]

had been reached, and there was little if any further improvement to be looked for. The best results now obtainable were :—

	B.Th.U. per H.P.-hour.
Steam turbines	14,000
Gas engines	10,600
Diesel engines	7,700

Both gas and oil engines had reached their limit as to size, but the steam turbine could be built in much larger units than had yet been attempted. Therefore, notwithstanding the considerably higher heat economy of gas and oil engines compared with the steam turbine, the latter would hold the field for large units both for land and marine service, the reason being that it was a true rotary engine, and it would occupy this position until a satisfactory gas turbine was evolved. There had been much theorising on the subject of the gas turbine during the last 15 years, and a few small experimental gas turbines had been uilt. So far, however, there had been no real progress, the main difficulty being to obtain material for the blading which would withstand the very high temperature of the impinging gas. There was also to be considered the loss due to compression of the combustible mixture of gas and air, which loss greatly reduced the intrinsically higher thermal efficiency of the internal combustion engine, so that under the best conditions it was not likely that the practical economy of the gas turbine would be more than a few per cent. better than the present gas engine. An experimental gas turbine must be of a very large size, and private enterprise would not be justified in incurring the great capital expenditure which would be necessary. The real object was to utilise the world's fuel supplies—coal, oil and peat—to the best all-round advantage and to that end increasing attention was being paid to devise means whereby fuel should not be burned to obtain heat until the so-called by-products had been separated. The recovery of by-products would only be economical in very large plants, and the same might be said of the generation of electricity in this way. Consequently, it might be expected that in the future, coal and peat would be gasified in producers of such a character as to recover the maximum amount of by-products, and that the remaining gas would be used for generating electric power. Generally the monetary value of the by-products was greater than that of the heat producing element of the fuel; hence, when they had been separated it might be said that the cost of the fuel would be negligible. In fact, it would be the gas which was the by-product. From this it followed that the small percentage of [illegible] gain in the gas turbine would be largely reduced in value. There was, therefore, justification for the conclusion that the gas resulting after the separation of the by-products would be used under boilers for generating steam for driving large turbo-generators. In as much as high vacuum was essential to economy with steam turbines, the principal requirement of such large power stations would be that they must be close to an ample supply of condensing water. As a secondary consideration they should be as near as may be to a coalfield or a peat moor and to the centre of the load.

The Audion.*

By G. VALLAURI.

A diagrammatic representation of the audion as used in wireless telegraphy is given in Fig. 1. The three electrodes are a, c and f. a is [illegible] in the form of a plate [illegible], but is sometimes cylindrical, c is the form of a grid and is interposed between a and f; f is [illegible] filament maintained in a state of incandescence by means of a battery of a few accumulator cells. Owing to the thermionic emission by the hot filament f, the current in Fig. 1 [illegible] does not depend [illegible] upon the E.M.F. [illegible] but also upon the current [illegible] frequently called the control system. [illegible]

[illegible]

* [illegible] 1917.

v_c, can be varied at will between certain limits by means of the sliding resistance, and, keeping v_a constant, the values of i_c and i_a are observed. The value of v_a is then changed and fresh observations of i_c and i_a are made. Each value of v_a gives rise to a curve connecting v_c and i_a, and these curves are shown in Fig. 2. They are called *characteristics* for the audion.

There are thus two equations connecting the four variables v_a, v_c, i_a and i_c, which may be written

$$i_c = \psi(v_c, v_a)$$

and

$$i_a = \chi(v_c, v_a).$$

The control current i_c is so small in comparison with the anode current i_a that it is negligible throughout the region considered, in

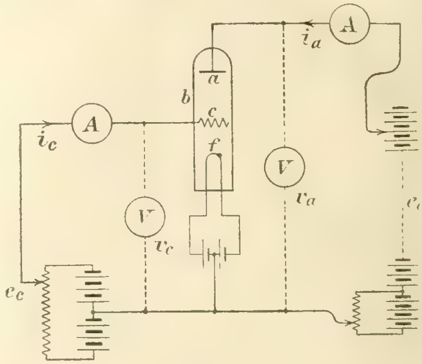

FIG. 1.

which v_c is negative. Again, since v_a is constant for each characteristic, the equation for it becomes $i_a = \chi(v_c)$, and it will be seen from an inspection of Fig. 2 that a considerable portion of each characteristic is straight, and that the straight portions of the characteristic are approximately parallel to each other. On plotting the family of characteristics on a three dimensional diagram it will be seen that the characteristic surface will be approximately plane

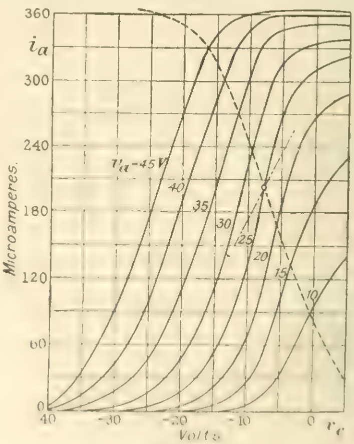

FIG. 2.

[illegible] region surrounding the little circle in Fig. 2. The equation [illegible] part of the surface is of the form

$$[illegible]$$

[illegible] taking the constants from the diagram, becomes

$$[illegible]$$

[illegible] analytical treatment is founded upon this [illegible] approximation and the conditions for acting as amplifier and generator are founded upon it. It should, however, be borne in mind that the action as rectifier depends upon the [illegible] of the characteristic surface. Further, the element of time has been ignored, since the measurements from which the characteristics of Fig. 2 are derived were made slowly. If the

changes have been effected rapidly it is possible that the effects of inertia and hysteresis might have been observable.

The audion as an amplifier depends for its efficiency upon the relation of i_a to the applied E.M.F. (v_c) in the control circuit, which may be in part a constant E.M.F. due to a battery, and in part an oscillatory E.M.F. due to any cause. If e be the amplitude of this variable E.M.F. and i the amplitude of the variable part of i_a it is shown, under the limitations above described, that $i/e = a/(1 + bR)$ where R is the ohmic resistance of the anode circuit. This fraction is taken to measure the magnifying or amplifying power of the audion. If the anode circuit contains L as well as a resistance R, there is no simple amplification, and e and i are not in the same phase. Where capacity is added the problem is still more complex.

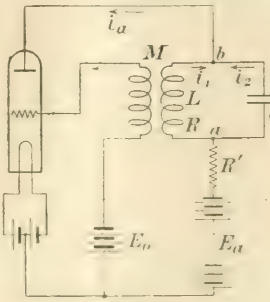

FIG. 3.

To employ the audion as a generator, the two circuits (control and anode) must be coupled externally. This may be performed magnetically or by means of condensers. When the coupling is magnetic the amplifying power compensates for the damping in the oscillatory circuit. With no capacity present the current is not oscillatory, but grows according to the equation,

$$i_1 = I_0 [1 - e^{[illegible]}]$$

If $M > \frac{b}{a} L$, the current i_1 grows asymptotically in the ordinary way. The cases for which $M = \frac{b}{a} L$ and $M < \frac{b}{a} L$ are not realisable in practice. On the introduction of a capacity in parallel with L the solution of the equation acquires the ordinary oscillatory form if

$$M = \frac{bL - [illegible]}{a}$$

where R is the resistance of the coil L and R' the resistance of the rest of the anode circuit (Fig. 3). Hence for persistent oscillations

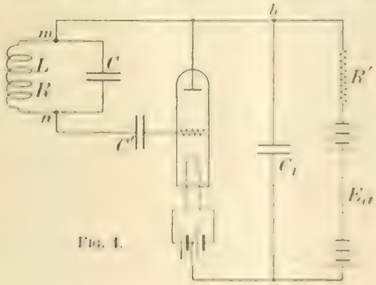

FIG. 4.

a particular value of the coefficient of coupling of M is necessary. Also M must be negative. [illegible]

In Fig. 4 [illegible]

are employed, and the relations between the capacities for the production of persistent sinusoidal oscillations are found. Also it is found that the anode current i_a is in phase with the control E.M.F. v_c, and in opposite phase to the anode E.M.F. v_a.

When the audion is used as a rectifier or detector the part of the characteristic surface lying beyond the plane region is employed. In the equation $i_a = I_0 + i$, I_0 is no longer independent of e. The action as detector depends upon the fact that a periodic E.M.F. applied to the grid or control circuit causes a variation in the mean value I_0 of the anode current.

The quantity $(\Delta_1 i_a - \Delta_2 i_a)/\Delta v_c$ [illegible] is taken as the [illegible] *power*, where $\Delta_1 i_a$ and $\Delta_2 i_a$ are changes in i_a for the small change Δv_c in v_c at two adjacent points on the characteristic. This is the second derivative of the function χ in

$$i = \chi(v_c [illegible])$$

and shows that the rectifying power is greatest for those parts of the characteristic where the curvature is greatest.

The paper closes with a very brief statement of the uses of the audion and the placing the receiving telephone instead of the resistance R_1 (Fig. 3) and the coupling of the self-inductance L with the circuit of the receiving antenna.

Individual Drive of Textile Machines.

Dr. J. F. Crowley recently voiced the opinion that the best results from the individual drive in textile machinery could only be obtained by co-operation of the textile machinist and the power engineer. Speeds have steadily advanced during recent years, but are still far short of those that suit the needs of the electrical engineer. The problem is complicated, as will be seen by reference to the accompanying diagrams. Fig. 1 shows the torque curve of a heavy

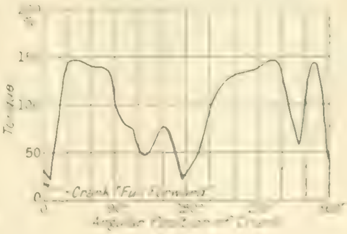

FIG. 1.

Jacquard loom for one revolution of the crankshaft. In the case of a plain loom the percentage variations are often greater. The curve was obtained by means of delicate electrical apparatus. In Fig. 2 is given the torque curve of a mule. Here again it will be

FIG. 2.

[illegible]

The Electrician.

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The Metric System.

Last week a discussion was held at the Institution of Electrical Engineers on the subject of the Metric system. As previously announced, the object of the meeting was to consider the effect which the introduction of this system would have on British trade, especially in markets where the British system is at present in use, and it was hoped that as a result of this meeting an authoritative statement might be made as to the feeling of the electrical industry, so that any hesitating policy might be avoided. Undoubtedly, the object in view was wholly desirable; so long as there is a hesitating attitude nothing will be done, and, therefore, it behoves the electrical industry to make up its mind as to what it desires. Now, those who are mostly concerned are traders on the one hand, and manufacturers on the other. We attended the meeting in great expectation that traders and manufacturers would be forthcoming to express their views in no uncertain way. Actually, however, scarcely a trader or manufacturer put in an apperance, and the discussion was largely carried on by those who were not most vitally interested.

At the moment the decimal movement may be divided into two parts, one being monetary and the other being concerned with weights and measures. The metre, of course, does not enter into the first, but from the point of view of trading it appears to us to be more important to settle the monetary side than that dealing with weights and measures. We are, therefore, glad to see that a distinct move is being made in this direction. The Institute of Bankers decided some little time ago that it would be well to have decimal coinage and to retain the £ sterling as our unit of coinage. This is essentially a matter for financial people, and if the bankers are in favour of the change we may safely assume that it is the best course to follow, and that the £ is the best unit, notwithstanding the arguments put forth in favour of the shilling and the florin. The only part of the scheme which we feel is unacceptable is the term "mil," which is already in use to denote the thousandth part of an inch. It is difficult to find an alternative, but something would be gained by spelling it "mille" so as to afford some distinction. The Association of Chambers of Commerce of the United Kingdom and the Decimal Association have now agreed to accept the decimal system based on the £ on a [illegible] with the Institute of Bankers, and thus the position is tolerably clear.

When, however, we come to weights and measures the question is not so simple. It is frequently pointed out that the adoption of the metric system would enable a larger export trade to be carried on in markets which are at present familiar with the metric system. This argument [illegible] two ways. If it facilitates export it ought also presumably to facilitate import from those countries into this country and into our colonies, for it is probable that if the change to the metric system were made in this country it would also be made in the colonies, some of which are already anxious to make the change. Judging from the remarks made at the discussion we are, perhaps, [illegible] that we should lose as much in one direction as we should gain in another, as far as trade is concerned, and, if so, the latter may be left out of account.

From the point of view of the engineer who has to make calculations there is no question that the metric system is preferable. Every engineer knows, for example, the advantage of the kilowatt over the horse-power, and in drawings and general work we suppose it is sufficiently recognised that the working to 32nds and 64ths is by no means convenient. Our present measures may enable us to provide various convenient short cuts in dealing with certain quantities, but in all probability those short cuts can be provided equally conveniently in the metric system. Apart, however, from the needless waste of time and energy in the use of complicated measures (which, by the way, could survive here as in other countries for popular use if desired), the important question is the effect of the metric system upon our manufacturers.

It was interesting to learn in the discussion that magnetos have been standardised by the Government in terms of millimetres. Also that the textile trade was opposed to the compulsory adoption of the metric system because of the difficulty that would be entailed in obtaining renewals for plant that must remain in existence. Inconveniences of this kind must of necessity arise, but they would pass away in the course of time. One of the few manufacturers who took part in the discussion was Mr. D. ADAMSON, who stated that owing to the use of the inch and its sub-division by powers of 2 he kept in stock 150 different sizes of tool, whereas corresponding German lists only disclosed about 50 sizes. He seemed to think this was a virtue in our present system, enabling the user to have so many sizes at his disposal. We must confess we feel that it is a defect rather than a virtue, for if the user can get on equally well with one-third of the number the need for a smaller stock is obviously to the advantage of the manufacturer, and ultimately to the user also, as it lessens the cost of production. Any means which enable those in other countries to work in a simpler way and to waste less time must place Great Britain at a disadvantage.

As we said before, the discussion was distinctly disappointing, and we fear it was not justified unless the manufacturers could be secured beforehand to express their considered opinions. It seems to us that the net result cannot be useful. Whether it would be possible to have an adjourned discussion at which the manufacturers taking part could be announced beforehand as definitely pledged to express their views we do not know, but we suggest that this would be the only means of securing a useful result.

Review.

The Principles of Electric Wave Telegraphy and Telephony.

By Dr. J. A. FLEMING, F.R.S. (London: Longmans, Green & Co.) 3rd edition. Pp. xvi + 911. 30s. net.

During the 11 years which have passed since the first edition of this book was published many text books of wireless telegraphy have appeared. Nevertheless, probably any student of the subject in this country, if called upon to write down a list of authors as they came into his head, would set Prof. Fleming's name at the top. The book took its place as a classic, not only because of the authority with which the writer was able to deal with many branches of the subject, but partly by reason of its early appearance in the development of the art, and not a little, it is likely, on account of its bulky proportions.

The new edition shows a noticeable increase in the last respect. The author states in his preface that the book has been in great part rewritten and rearranged. Certainly much new material has been added, and it is open to question whether some could not advantageously have been omitted. Indeed many will think this is one of the cases where a revised

edition is like new cloth put unto an old garment. The Fleming Cymometer in the guise of a practical laboratory instrument, for example, is not well matched by the cathode stream amplifier; and the book tends to be unwieldy. Probably its mathematical and historical features were, and remain, the most valuable. The book was never one in which the student could easily find his way, and any patchwork quality is almost inevitably intensified by the process of revision in the way of bringing up to date. In our opinion, its value would be considerably enhanced by more accurate paragraphing and a fuller use of sub-heads.

The great advance in one branch of the art, long-distance transmission, since the first edition of the book appeared, is well exemplified by the change of frontispiece, intended doubtless in each edition to portray the current high-water mark of achievement in this direction. The photograph of the old Poldhu station, with its wooden towers, employing the then enormous power of 20 or 30 kw., is replaced by an excellent distant view of the new Marconi station near Carnarvon, with its great aerial on masts 400 ft. high, its ten-times augmented power, adapted to set up electromagnetic waves several miles long.

The book remains divided into the same three main sections Electric Oscillations, Electric Waves and Electric Wave Telegraphy. The more mathematical portions naturally are but little modified. It is to be regretted that, although the author finds it necessary repeatedly to warn the reader about this peculiar [illegible] the *half* period [illegible] oscillation constant [illegible] "centimetres" of inductance, remains to worry the many students to whom the question of units is a real difficulty. Even apart from [illegible] more convenient quantity for the wireless engineer than is the tiny C.G.S. [illegible] of inductance.

The first few sections of Chapter II., on high-frequency electric measurements [illegible] on the inductance and resistance of coils of wire of the uneven distribution of high-frequency current over the cross-section; and we welcome some assistance in the form of numerical tables towards the calculation of inductance coils in practical work.

In Chapter III., on Damping and Resonance, a helpful mathematical introduction is followed by a lengthy analysis of the behaviour of two coupled oscillatory circuits. These pages require very careful reading, and the student who tries to master this difficult problem will be disappointed to find that, after all, the general case is not dealt with, nor even any very practical approximation to it. This would not be just cause for complaint, if it were not for the difficulty in seeing precisely what are the limitations of the treatment, for these are not sufficiently clearly exhibited. A section entitled General Theory of Resonance treats [illegible] the case of a steady undamped E.M.F. [illegible] set up by a condenser discharging through a spark gap. Moreover, the treatment of the [illegible] coupling between the circuits [illegible] [illegible] the analysis.

[illegible] almost untouched. Of the hundred and [illegible]

by the Marconi Company or the Poulsen-Pedersen apparatus, is not referred to; nor is even the Marconi high-tension key described.

Some of the practical counsel is not very reliable. It is arbitrarily stated that an antenna loaded with inductance may show a ratio λ/h as high as 1·7 or even 2; whereas much higher values are every-day practice. Transmitting jiggers, we are told, should be wound of stranded wire of S.W.G. 40; and it is necessary, without reference to power, to immerse the whole coil in oil. Without naming the form of receiver, it is said that the antenna current must be 40 to 100 microamperes for good reception. "A suitable call has been devised as follows": A high resistance moving-coil galvanometer is fitted with relay tongue and local contacts and substituted for the phones. No such galvanometer device, we are sure, has ever been made to give practical service; and in claiming selectivity by the heavy coil responding to long dashes and not to ordinary Morse signals, the author is, of course, mistaken. A series of Morse dots and spaces would have the same effect as a continuous dash of half the strength; and Morse letters would be more effective.

Amongst the subjects which one might expect would receive some or fuller mention are the theory of quenched spark working, and low frequency resonance in spark transmitters, and the production of precisely one or a sub-multiple of one spark per half cycle. In a description of a Telefunken set, an alternator having a frequency of "300 to 500 or more" is said to produce 500 or more spark discharges, which are quenched "instantly." Nothing of the theory governing telephones and telephone transformers is given, although the Campbell mutual inductance bridge for acoustic frequencies, here rather misleadingly referred to as high frequencies, is described at considerable length. The point form, but not the granules form, of the Brown telephone relay is described. In the section on the Efficiency of Radiotelegraphic Stations the interesting calculations of Dr. Eccles of the transmission efficiencies of different systems would be in place. Remarkably little information is given of the laboratory methods of measurement of wireless apparatus—measurements, that is, at wireless frequencies as opposed to acoustic frequencies, about which a good deal is said—and the conception of a simple concentrated circuit equivalent to a circuit containing distributed capacity, inductance and resistance (such as antenna-earth) is most inadequately, even erroneously, set forth; and the experimental determination of the values is nowhere described.

The chapter on Radiotelegraphic Transmission has been very much expanded from the corresponding matter in the first edition, and now occupies 70 pages. The part played by the earth in assisting, and opposing, propagation over its surface is discussed, and a full abstract of Zenneck's theoretical investigation is given. [illegible] others are dealt with, and the theory and phenomena of temporal variations are discussed. An interesting method, due to the author [illegible] This is a very valuable chapter, dealing ably with abstruse and as yet largely unsolved problems [illegible] the British Association Committee, formed [illegible]

[illegible]

Discovery and Invention.*

By Sir DUGALD CLERK, K.B.E., D.Sc., F.R.S.

The Council of the Royal Society of Arts, on the retirement of Sir Henry Trueman Wood from the important office of secretary after 45 years' connection with the Society, desired to mark their sense of the great services rendered by Sir Henry by instituting an annual lecture to be delivered at the Society. This lecture is to be called "The Trueman Wood Lecture," and, in accordance with Sir Henry's wishes, it is intended to discuss some interesting point or problem in connection with the application of science to the needs of civilisation.

In the present time it is important to form clear and accurate ideas as to the differing nature of discovery and invention. Even scientific men often confuse the functions of discoverers and inventors. It is too often assumed that discoverers are also—or, if they desire, can be—inventors. This is hardly ever the case. The type of brain power which is found in great discoverers is quite different from that of the great inventor.

Scientific research in physics and chemistry is of two kinds: one deals with the nature of the phenomena observed, and endeavours to arrive at some explanation of the why and wherefore of the particular occurrence; the other endeavours to discover hitherto unknown phenomena. Naturally the earlier investigations dealt with known phenomena. The discovery of a numerical law does not constitute an explanation of a phenomenon. Gravitation is as great a mystery now as in Newton's day. Cohesion, light, electricity, chemical action and life—all appear equally inexplicable.

Yet although we have failed to understand gravitation, we can rely on the great law that attraction between bodies varies directly as the mass and inversely as the square of the distance. We can trust the generalisation that within our experience matter is neither destroyed nor created. The great laws of thermodynamics, the mechanical equivalent of heat and the law of heat conversion may also be used for prediction.

The object of abstract investigation is to endeavour, by questioning Nature, to arrive at some comprehension of the nature of matter and energy in its different manifestations—physical, chemical and of life. This is the fascinating work of the abstract investigator, and should be conducted without any aim other than true understanding.

Such work is not usually compatible with the power of invention. Accordingly the inventor and designer is a man of different type from the abstract investigator. The abstract man must be intensely specialised; the inventor must have a wide acquaintance with the properties of all the materials with which he works, and must also have knowledge of the particular needs of the industry which he intends to improve.

That the work of invention is not usually performed by the discoverer and investigator of new sequences and laws is evident from an examination of the records of the Royal Society. From 1820 to 1915, of 21 Presidents only four could be considered to be inventors—Sir Humphry Davy, miners' safety lamp and electrolytic decomposition of the alkali metals; the Earl of Rosse, designer and inventor of the great reflecting telescope; Lord Kelvin, inventor of the mirror galvanometer, the syphon recorder, and many other electrical [illegible]; and Lord Lister, the great medical inventor, [illegible] the discoveries of Pasteur [illegible] to the purposes of surgery. [illegible]

[illegible]

[illegible]

* [illegible]

ture. About 1866-67 Varley, Wheatstone, and Werner Siemens separately, but almost simultaneously, proposed to use the current generated by the machine to magnetise its own field magnets, and this proved to be a principle of first-class importance. The first application of the self-exciting principle was made about 1870 by the English instrument maker, Ladd. The Gramme dynamo, introduced in 1870, became very successful; it has been extensively used.

Yet much remained to be done; the dynamo was not yet self-regulating. It is an interesting fact that in 1883 Lord Kelvin (then Sir William Thomson) had a gas engine of my invention and design fitted up in the university laboratory to drive a Siemens shunt-wound dynamo for the supply of electricity for lighting his house in the university grounds. To alter the output of the dynamo, he arranged a variable resistance for the control of the shunt current passing to the exciting field. This resistance consisted of a small wheeled conductor arranged to travel up and down an inclined rail; at each position the appropriate resistance was inserted in the field circuit. The operation was mechanical and very ingenious, and it worked quite well. Very soon, however, the compound-wound dynamo was introduced, the invention again of Varley and others. In the year 1884, which saw the introduction of the self-regulating compound dynamo, 53 years had passed since Faraday's discovery of the fundamental action on which the great modern industry of electric light and power is now firmly based. Faraday died in 1867, 17 years before the more advanced application of his work.

In other great inventions the same slow process of development is always found; the steam engine from Newcomen to James Watt and on to Parsons, followed the same course of step by step improvement; but in this case the engine came into existence before any true theory of the nature of heat was arrived at. What would logically be considered the fundamental science did not exist in either Newcomen's or James Watt's time, and Watt died before the beginning of thermodynamics as a science.

The study of steam and other heat engines apparently gave rise to the science of thermodynamics, which has given us, perhaps, the greatest generalisations known to science, applicable equally to motive power, physics, and chemical action.

Parsons was fortunate in finding thermodynamics fully understood when he began in 1884 his great work on the steam turbine; but, with all the help of abstract laws, he found much to investigate in the flow of steam jets, &c. Here the investigation had to be made on what he as an engineer had successfully produced.

The long-continued action of many minds is also characteristic of the brilliant progress of the internal-combustion engine. So far back as 1680 Huyghens proposed to use the explosion of small charges of gunpowder in order to obtain motive power, and Papin in 1690 continued his experiments without success. An explosion engine using inflammable vapours was described in an English patent by Robert Street in 1774. As early as 1817 Prof. Farish, in Cambridge, showed an explosion engine in operation on his lecture table. In 1820, also, the Rev. W. Cecil, in a Paper before the Cambridge Philosophical Society, described a hydrogen engine. Even the first definite and accurate proposal to compress the charge before explosion was made by William Barnett in 1838, some years before Joule's first Paper was read to the British Association on the Mechanical Equivalent of Heat.

Internal-combustion engines were thus proposed long before the inventors could have availed themselves of thermodynamics. Even now, in 1917, some 79 years after the proposal of compression, we are still inventing and designing new and better internal-combustion engines, and shall certainly take many years longer without approaching finality. In 1876, when I began work upon the subject as an inventor and designer, I could find no record of experiments made upon the maximum pressures attained by varying mixtures of coal gas and air mixed at atmospheric pressure and ignited by electric spark or flame. The only experiments in existence were those of Bunsen, conducted in small glass tubes. I was able to investigate the times and pressures of gaseous explosions under various conditions of mixture, initial temperature and pressure. These experiments were published in 1886, and proved most useful to engine inventors and designers. At the same time they brought to light many important facts interesting from the purely scientific standpoint.

The [illegible] of invention, design and scientific discovery is evident in all considerable inventions. This is also true of the development of flight. Ideas were plentiful hundreds of years past. Leonardo da Vinci made many experimental wing models, and attempted what we should now call gliding experiments, but nothing practical came of it till the time of Langley, in America. Definite progress was made by the gliding experiments of Lilienthal and Pilcher, and Maxim carried the demonstration a stage further: but

real flight of heavier-than-air machines was not attained till the petrol engine was developed to a sufficient extent to enable a light engine to be mounted on a glider. This was accomplished by the brothers Wright in America about 1906.

A somewhat surprising lack of appreciation is shown by some very distinguished mathematicians of the conditions of practice and the limitations of mathematical prevision. It is illustrated in their well-known contempt for experimental physics as compared to mathematical physics. The particular science is stigmatised as "empirical." Mathematical science is not empirical; but mathematical truth is accurate because it is defined so. The thinking of the mathematician would be quite sterile if he confined himself to his desk and chair, and endeavoured to evolve the complicated facts of Nature out of his own consciousness. The work of the mathematician is most useful, and it is necessary to success equally in discovery, invention and design; but it is useless alone—it has never performed, and cannot perform, the marvels of prevision claimed for it by some of its followers.

With regard to chemical discovery and invention, the science has followed the same course. Before the existence of any chemical science in the modern sense, mankind for ages conducted many manufacturing processes, such as soap-making, glass-making, iron and copper smelting, sulphuric acid manufacture from green vitriol—hence the old name "oil of vitriol"—brewing and distilling alcohol from many sources, and wine growing and making, dyeing, and so on, all of which involved chemical operations. Alchemy, too, led to many experiments which produced a knowledge of chemical sequences.

The discovery of radioactivity by Becquerel, and the separation of radium salts by Madame and Prof. Curie, supplied Rutherford, Soddy and Ramsay the basis for investigation which proved the existence of so-called atoms, which disintegrate spontaneously and form other bodies. This, with the brilliant work of Sir J. J. Thomson, proved the existence and properties of the electron, which may yet throw startling light upon the ultimate constitution of matter, the nature of electricity and the nature of mass, and even give a key to the nature of gravitation, at present so entirely inexplicable. Chemistry is thus rapidly evolving laws of a most general character, and finding unit in the hitherto bewildering complexity of its sequences.

The marvellous progress in the study of [illegible] problems has been produced by [illegible] investigation suggested generally by practical experience and the testing of hypotheses flowing from the investigation. Sir Berkely Moynihan has recently traced the history of many [illegible] operations, and clearly shows the interdependence of abstract investigation and surgical practice. He [illegible] as follows: "A discovery is rarely the work of one mind. It is one observation added to another that makes the supersaturated solution from which the crystal of truth at last precipitates. [illegible] credit to Pasteur for his [illegible] to the development of the antiseptic method. The exploratory work, the pioneer work, all that was [illegible], therefore, by a French [illegible] and an English surgeon."

Both discoverer and inventor [illegible] by the intense desire to produce new things and understand [illegible]. Neither [illegible] actuated by pure commercial instinct, [illegible] both, [illegible] citizens of the world, naturally desire [illegible] position, but the love of money could not [illegible] impetus sufficient to maintain either through the vicissitudes of the laborious life necessary to attain the end. To succeed [illegible] there must be entire and long continued devotion to study and [illegible] inspired by an enthusiastic appreciation of the [illegible] possibilities.

Electrical Cooking as Applied to Large Kitchens.

The following is a report of the discussion on Mr. W. A. [illegible] paper [illegible] December [illegible] the Institution of Electrical Engineers [illegible]

Mr. A. F. [illegible]

Mr. W. [illegible] but their [illegible] been adopted, was [illegible]

below the estimate. [illegible] its cleanliness, and [illegible] was saved [illegible] systems.

Mr. H. J. CLARKE, who [illegible] day, said he did not regret [illegible] current per meal was below the [illegible] it was 0·45 unit. A second plant [illegible] an average of 2,500 meals per day.

Mr. C. G. NOBBS said the first consideration should be running and maintenance costs. The comparison [illegible] A and B [illegible] easier if the water heating were [illegible] as a unit basis. For the 1,500 [illegible] 680 lb. for B, exclusive of water boiling, the consumption would be 380 units per day for A and 220 for B [illegible] 0·94 lb. for A and 1·38 lb. for B. The consumption of electricity represented 0·246 unit per meal for A and 0·4[illegible] for B, [illegible] being partly due to the other duties performed by B. Domestic installation work had been set back during the last two or three years, but the heavy side had had an impetus. The [illegible] were rather small. The percentage of the installation cost would be the simplest way of explaining it to a prospective customer. A would be about ¾ per cent. and B about 2½ per cent., including wiring, &c. The initial cost of installation A might have been stated minus nickel plating and other embellishments, which were not in the canteen equipment, and the maintenance based on those net figures. Also in B the wiring must be less than in A. He (Mr. Nobbs) calculated that the maintenance cost was 1¼ per cent. per annum for A and 2¾ per cent. for B.

Mr. H. BRAZIL said he was rather disappointed to find that no details of the construction were given. Reliability of the heating elements was vital. He thought hot plates were of little use, because they had to transmit the heat from the elements to the vessel, and if the vessel bulged at the bottom an enormous increase of power was necessary. The life of the elements in grills was short. Mica strip elements had a tendency to buckle if only attached at the ends, and he would be glad to have any information from the author as to the best way of constructing them. He (Mr. Brazil) had come to the conclusion that mica was not the best material to use. He had tried fireclay, upon which he put 114 watts per inch of length, compared with 64 watts used with the mica, and after 200 hours use it showed no signs of deterioration. Manufacturers should consider the question of making apparatus for 400 volts, so as to do away with the trouble of balancing.

Mr. GRESLEY said the Board of Trade [illegible] Electricity could easily be substituted for lighting, but the difficulty was with regard to cooking. Could electric cooking be applied commercially to dining cars?

Mr. E. H. WILLIAMS (Jackson Stove [illegible]) [illegible] ness depended on the [illegible] men. Running costs were more important than initial costs. The specially constructed ovens supplied by his company attained a temperature of 600 deg. [illegible]

Mr. P. [illegible] of 100 kw. to 200 kw. [illegible] produce satisfactory and suitable switchgear.

Mr. W. E. [illegible]

Mr. W. [illegible]

Mr. M. [illegible]

the danger of fire. He thought solid top boiling tables were preferable to hot plates.

Mr. HOLMES (a restaurant manager) said he used electric cooking, and it was all that could be desired.

Mr. C. W. CROSBIE said in installation A the maximum demand to kilowatts installed was 35 per cent., which was lower than in the other cases, and this showed that the maximum demand had been kept down by the pre-heating of water. By such means, and by spreading the demand as much as possible over the non-peak hours, which could be partly effected by using elements at a lower temperature during the peak hours, the load factor would be improved and the maintenance charges would be reduced. To assist in this improvement of the load factor a longer time would have to be allowed for water boiling. The author mentioned a 350 kw. installation in which the boilers amounted to a loading of 55 kw. to 60 kw., which was a large proportion of a peak demand that might reasonably be estimated at 190 kw. Thermal storage would also greatly improve the load factor, and for every 1 per cent. increase in the load factor 2 per cent. reduction could be made in the price of current.

Mr. E. T. WILLIAMS said if steam were used for heating water up to a certain point, why not do the whole of it by steam? It would be useful to know the cost of maintenance per meal, and also whether all the meals were taken at once or at varying times. One would like to get to the bottom of the faults question, if the author would state what they were. In the case of high candle-power gas-filled lamps, the high temperature difficulty was got over by taking the leads from the lamp-holder frame to a box where there was an insulated connector, and continuing from that with the ordinary wiring. The capital cost as given by the author tended to be misleading. This was a factor which would have considerable influence on prospective users of electric cooking plants.

The AUTHOR, in replying to the discussion, said no sales manager would let a consumer believe that the cost of power was the primary factor in a cooking plant, and there were many other advantages which were well worth the money spent. With current at ¾d. one could safely compete with gas at 2s. a thousand. He had been successful in reducing the size of joints cooked to about 15 lb. In reference to the comparison of installations A and B, one was at munition works, and munition workers could not be induced to economise in food. Cooking on trains could be done by a petrol set, or by batteries boosted at certain stopping places, and the battery discharge, if not too heavy, could be kept up by a dynamo driven from the train axle. There was no difficulty in securing the cooking of much of the food off the peak. The best scheme for distribution was alternating current single phase 200 volts, which would dispense with the out-of-balance currents. He would reply more fully in the Journal.

A vote of thanks to the author concluded the meeting.

Correspondence.

THE GIVING OF PROXIES

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am very unwilling to enter into a discussion on the matter, but your note on my letter in last week's issue appears to me to do less than justice to the Council.

I do not know the member in question even by sight, and I [illegible]

[illegible]

[illegible]

[illegible]

[illegible] M. [illegible]

[The third paragraph of the above letter [illegible] The Council would not have called the meeting [illegible] Consequently every proxy given to the Council was given against the member in question, and given by members who at the time knew nothing about the case. Supposing a majority at the meeting decided in favour of the member, it was only necessary for the minority to demand a poll to have the decision reversed —*i.e.*, to obtain expulsion. This is not what we generally understand by British justice.—ED. *E.*]

"THE DESIRABILITY OF PROFIT."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is with great reluctance that I write again, but I am impelled to do so by another statement you make in commenting on my letter in your issue of November 30th. You state that "although the true Socialist would not talk so glibly, the mass of so-called Socialists do so, apparently knowing nothing of economics."

I formerly held some such erroneous (?) opinions about the mass of so-called Socialists and their knowledge of economics. It is in the holding of such erroneous opinions by those who, like myself, are quite safely outside the mass that danger lies. People outside this mass do not attempt to ascertain the extent of the knowledge of economics, or of any other subject, possessed by the individuals of whom the mass is composed.

I think it is time for us to look facts in the face, and to admit the possibility of the mass having learned a great deal during the last few years. I am convinced, as a result of inquiries made of members of the mass and from general observation, that they do know a great deal that is important about economics. I know, for instance, that they have the audacity to differentiate between capital and the capitalist. They know that the former is their friend, while the latter is their enemy. The capitalist, on his side, knows that Labour is his enemy. Why should we not face the truth in this matter as we do in engineering matters. The capitalist and the worker are enemies. The object of the capitalist is to get as much as he expediently can out of the worker. The worker's object is to get as much as he can out of the capitalist. Each side knows it, so why not admit the fact openly? It is the plain truth, so why boggle?

The mass of the workers is Socialist, and is thinking socially and economically. The workers have learned their simple, yet vital economics thoroughly, from their own well-informed speakers and from recognised writers. It is useless to burke this fact. It simply is so, and the statement may be tested anywhere.

For many years the process of Socialist education has been going on, as everybody knows. We don't like to admit it, though we are confronted with its results every day of our lives. We can't open a newspaper without seeing that the workers are alert to facts.

The average Socialist knows quite well that he cannot do without capital; he knows, just as well, that he can do without the capitalist. The capitalist knows that he cannot do without Labour, and that, therefore, he cannot do without the labourer. Capital and the capitalist can be separated. Labour and the labourer cannot be separated, and therein lies the capitalist's trouble. He knows he cannot have labour without the labourer, under any conditions whatever, and that it is useless to attempt to separate the inseparable.

Labour is conscious of the fact that it has now to take capital and the capitalist together, yet is conscious of the fact that it has no use whatever for the capitalist, and that as capital is the friend of labour, and the capitalist the enemy of labour, the object to aim at and to work for is the separation of capital from the capitalist.

I submit that this separation is actually the conscious, deliberate aim of Labour. It is obviously so, from signs apparent to anybody. It is sheer folly to pretend that Labour is not aware and alert, and that it knows nothing of economics. The writing on the wall is plain. Labour and the capitalist are enemies. Let us admit the truth. Then we can tackle properly the problems arising out of the situation. That the truth is unpalatable is no excuse for denying it, or for pretending that the situation is otherwise than we know it to be.

Labour is awake. Labour is conscious, and Labour in the mass is Socialist, and does know something of fundamental economics. It may be little, yet it is vital and fundamental. A little fundamental knowledge is a dangerous factor, if ignored. Then why ignore it? The war is keeping Labour quiet. What is to follow?—I am, &c.,

London, Dec. 11. F. W. SHORROCKS, A.M.I.E.E.

[Our correspondent identifies Labour with the "mass of so-called Socialists," which is unjustifiable. It is largely a matter of definition, and the fact remains that there is much loose talk on the subject, which tends to do infinite harm among those who know nothing of economics. As to the "Capitalist," this is more often than not another name for capital, so that separation is not an easy matter. Every shareholder is a capitalist. There are also other points with which we disagree, such as to the inherent antagonism between Capital and Labour, but we regret that we cannot devote more space to this subject or continue the correspondence.—ED. *E.*]

Glasgow Tramway Accident.

Col. Pringle held an inquiry at Glasgow on the 13th inst. into the accident to a tramcar which occurred on Dec. 5, resulting in three persons being killed and 39 injured.

The permanent way engineer of the tramways department (Mr. J. GRIERSON) said the track from the junction at Grange-road to Victoria-road was relaid in August, 1907, and the curve was relaid in April, 1912, where the accident occurred. If the speed of the car on the curve was more than five or six miles an hour, there would be a tendency for the wheels to leave the rails, and the over-turning of the car was probably due to too high a speed.

Evidence was given to show that the car which had overturned was first put into service in September, 1913. It was fitted with a Newall magnetic brake for power and a mechanical hand brake. The brakes were found to be in good order after the accident. The speed limit on the curve was four miles an hour. There was no Board of Trade stop before the curve, but there was a Corporation stop on entering Victoria-road.

The driver of the car, JAMES CAMERON [illegible], was 16 years and five months old. He entered the service of the Corporation in September last as a conductor, and a month and a half afterwards he went to the motor school. He received about a week's instruction and subsequently he was about 14 days along with a driver on the road. Thereafter he was for 30 days driving on probation, and was passed on the Saturday previous to the accident. On the day of the accident he came on duty at 6.55 a.m., and went off about 10.30 a.m., resuming about 1 p.m. until 7 p.m. He would have gone off duty for the day on reaching Kirklee. He took the particular car over for the first time at Kirklee about 1 p.m., and made three trips between there and Nether[illegible]. When the accident happened (about 6 p.m.) it was dark, and he did not observe the light round the corner in Victoria-road until he was near the curve. He applied the hand brake when about 20 yards off the curve, and when 10 yards away he noticed the light in Victoria-road [illegible] the car rails. He then applied the hand brake harder, but, seeing that had not apparently any effect, he applied the magnetic brake. He gave the brake three notches and when put on the curve he [illegible] the [illegible]. He was going at about eight miles an hour when 10 yards off the curve, and was just thinking of applying the reverse [illegible] when the car gave a violent jerk and he was thrown from the [illegible]. On regaining his balance he again got hold of the handle [illegible] the car was about half way round the curve the two inner wheels lifted, and the outer wheels left the rail. [illegible]

[illegible]

Mr. [illegible]

[illegible]

Mr. M[illegible]

[illegible] unmarried men were exempted and only [illegible] men over 35 years of age were exempted. It took very exceptional women to drive a car. They had trained 800 women and had only 258 driving. Many women had left because they could not stand the strain. The women were not inclined to offer their services in winter, principally owing to the dark roads. There were 146 boys under 18 years of age in the service, of whom 39 were qualified, 51 training, and 56 conducting. He considered the three essentials for qualified motormen were physique, intelligence and temperament. The first of these they did not get in a lad in every case, but so far as intelligence went a lad was often better than a man of 21. As a rule one had to make a selection in the matter of temperament. It was obvious they could not obtain such good conditions of public safety with a large body of short-service men as they could with men of greater experience. The Corporation had had correspondence on the subject with the Director of Recruiting. They also had several letters from the substitution office, who intimated they were sending on men, but it ended there. Now men, women, and lads employed as motormen worked 54 hours a week and their wages varied. Boys received 33s. 9d. or 35s. 11d. per week, married men 40s. 3d., single men 38s. 1d., and the maximum for old, experienced men was 54s. 5d. Since the abolition of the clearance certificate the tramway department had lost 111 skilled drivers—64 men and 47 women. They had lost also rather less than half the number of inspectors and timekeepers employed in pre-war days. Consequently the discipline was not so good as before the war. He could find places for 200 motormen at once. They wanted closer service. Figures showed in factories, &c., that about 150,000 workers were employed in Glasgow and neighbourhood. If the department had more cars they could use them.

After the evidence of two tramway inspectors had been heard the inquiry was closed.

Legal Intelligence.

The Attorney-General (at the Relation of the Gas Light and Coke Co.) v. The Metropolitan Borough of Hackney.

The Court of Appeal on Tuesday delivered judgment in this case.

Lord Justice SWINFEN EADY said: The relators complain that the defendants, who are empowered to supply electrical energy within their district, are committing breaches of Sections 19 and 20 of the Electric Lighting Act, 1882. They complain that the defendants are supplying electrical energy for lighting on different terms instead of the same terms to persons taking under similar circumstances a corresponding supply contrary to Section 19. They also complain that the defendants are showing undue preference to persons taking current for lighting who also take it for power, contrary to Section 20. Mr. Justice Astbury decided that the relators had failed to prove any breach by defendants of the statutory provisions, and dismissed the action and the relators' appeal. The scale of charges of which they complained was contained in a circular issued by defendants in July, 1914. After quoting the scales for lighting, he said: Scale B was for power. Alternative No. 1 laid down a fixed charge of £1 per quarter per kilowatt of maximum power demanded, and a charge for electrical energy used of [illegible] per unit, but consumers paying under the scale were allowed to use 20 per cent. of the energy consumed for lighting. There was an alternative No. 2 for power, about which no question arose: "For any quantity of electrical energy used each quarter, 1½d. per unit." In October, 1916, and before the issue of the writ, the defendants issued a further circular in which they explained that customers paying under the B1 scale for power were allowed [illegible] 20 per cent. [illegible] of energy consumed for lighting the factories and workshops premises in which the motors were installed, provided that the whole supply was taken from the same service meter. The action proceeded below upon the footing that the terms offered by the defendants [illegible] in the first circular [illegible] and that the premises for which light could be used under the B1 scale was limited to lighting the place for which energy for power was also being taken and that the supply for both purposes should be taken through one and the same [illegible]

[illegible] energy. The def[illegible]

[illegible]

In approaching the consideration of the matter in dispute it must be borne in mind that customers affect the central supply station differently according to the different circumstances under which they take current. The purpose for which current is taken is immaterial except so far as the station is affected by the amount taken and the circumstances under which it is taken. An ideally perfect customer would be one whose maximum demand on the station was also his minimum; and whose load remained constant, and endured for each hour of the 24, and throughout the whole year of 8,760 hours. It is to the advantage of the electric light undertaking to have customers for energy during the day, so that when its plant is not being used to supply energy for light it may still be employed in an earning capacity by supplying energy for power. The plant must be capable of meeting the maximum demand upon it at any moment of the 24 hours, and the less the demands made by different customers synchronise, and the more evenly the aggregate demand of customers is spread over the 24 hours, the smaller will be the size of the plant required to meet the maximum demand. What is termed the "diversity factor" is the proportion which the sum of the customers' maximum loads bear to the load actually observed at the station, and this depends upon how far the demands of customers are coincident; the less customers' demands coincide the better for the station. Speaking generally, it is agreed that customers for power have a better "load factor," and more favourably affect the diversity factor of the station than customers for light. Indeed, a figure of 25, or 25 per cent. was accepted as a general figure of "load factor" for power users, and the general figure given as the "load factor" of light users was 12·5. Again, the "diversity factor" of the station is, speaking generally, more favourably affected by power users than by light users. There is great coincidence of demand among light users, who, speaking very generally, require light when darkness comes on and not before, and use it for about the same number of hours. With power users, on the contrary, there is much difference *inter se* as to their hours of work and the times when their maximum demand for power arises, and this smaller coincidence assists the power station. It is essential to bear in mind the effect of "load factor" and "diversity factor" on the working of an electric undertaking when considering the scale of charges. It appears that defendants' charge under scale A1 for lighting is nearly double the charge under B1 for power. Under A1, if the unit be taken at 5d. for the purpose of calculating the costs at one hour supply at maximum demand, and then all further current consumed be charged at 1d. per unit, the annual charge per kilowatt of maximum demand will be £7. 11s. 8d., that is to say, four quarters multiplied by 91 day-hours at 5d. per unit, as against the fixed charge of £4 per year per kilowatt for power, and the charge for current will be 1d. per unit for lighting and ½d. per unit for power. [illegible] for light only or power [illegible] the position [illegible] allowed [illegible] lighting 20 per cent. of [illegible] power user consumed for lighting 20 per cent. of current taken, his load is rendered [illegible] class a power-user, although consuming 20 per cent. of current for light, [illegible]

have the same load factor, although one uses current for light, it follows that without using current for light they would have had different load factors, and as such would have been charged at different rates if worked out per unit per consumer; it is only by reason of one of these customers also taking current for light and so adversely affecting the load factor, that he is reduced to the same level or charge as the other customer who has a worse load factor than his own for power only. The effect of the sliding scale is that it does in fact introduce and adjust a third scale for power and light combined, the charge being higher than would have been the charge for power only, and lower than would have been the charge for light only. The appellants have, in my opinion, failed to show any breach by the defendants of either Section 19 or 20 of the Act of 1882. The case of the Attorney-General *v.* The Long Eaton Urban District Council is clearly distinguishable from the present. In that case, where power and light were both taken, the charge was at a lower rate than when power only was taken, although the customer was not so good a customer to the station. Again, a difference was made when partial lighting only was taken, so that if any lighting was obtained from any other source the higher rate was charged. The Long Eaton case cannot govern the present. In my opinion the appeal fails, and should be dismissed.

Lords Justices Warrington and Scrutton also delivered judgments, dismissing the appeal, which was accordingly dismissed with costs.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1916 Specifications.

7,062 Robinson, H. Magneto-electric machines. (16/11/16.) 110,760.
9,554 Mason, C. T. Method of and apparatus for electrical distribution for use with ignition systems. (19/6/15.) 100,742.
10,933 Fritsch, G. A. Electric switch controls. (2/8/16.) 110,768.
13,486 Woodhouse, A. E., & Husband, F. Electrically-heated soldering bolt or bit (22/9/16.) 110,564.
14,957 Oulianine, S. Electric relays. (20/10/16.) 110,569.
15,027 Broucher, D. Mechanical appliance for automatically shutting off the supply of gas, and/or switching off current of electricity at any desired time. (23/9/16.) 110,572.
15,036 Longford, H. G., Longford, W. W., Clark, W. A., & Morris, T. Electrical intensifying system. (23/10/16.) 110,574.
15,076 Wijk, P. G. Van. Overload electric switches or cutouts. (15/6/16.) 107,365.
15,077 Hay, C. E., & Sullivan, H. W. Loading coils for superimposed telephone working and other purposes. (23/10/16.) 110,578.
15,177 Coulson, W. T. Portable electric signalling lamps. (25/10/16. Cognate application, 5,394/17.) 110,592.
15,197 British Electric Transformer Co. & Renfree, T. R. Electric transformers (25/10/16.) 110,594.
15,310 Nuttall, E. Electric flash lamps. (27/10/16.) 110,611
15,365 Svombo, C. Trolley heads for electric tramcars. (27/10/16.) 110,612.
16,090 Pugh, M. E. Electrically operated striking device for clocks. (9/11/16.) 110,629.
16,155 Boulton, A. H., & Boulton, J. H. Ignition magnetos for internal combustion engines. (10/11/16.) 110,630.
16,452 Butt & Co., F. R., Bigge, H. F., & Butt, F. R. Mercury breaks or electric interrupters. (16/11/16.) 110,635.
16,892 International Electric Co. & Rocse, H. E. R. Telephone instruments (21/11/16.) 110,640
17,003 Western Electric Co. High-frequency signalling, particularly applicable to wireless telephony. (29/11/15.) 102,500

A method of electrical signalling wherein signals are transmitted in the form of a modulated high frequency carrier wave, and combining with the received oscillation locally generated oscillations of the same frequency as the carrier wave, and impressing said combined oscillations upon a detector.

17,998 Flannery, J. M. Electric batteries. (14/12/16.) 110,652.
17,999 Flannery, J. M. Electric batteries. (14/12/16.) 110,653.

1917 Specifications.

220 Murray, T. E. Apparatus for electric welding. (12/1/16.) 103,293.
2,093 Thompson, R. J., & Thompson, J. Wireless telegraph apparatus. (12/2/17.) 110,655.

A wireless telegraph receiver apparatus, comprising an aerial, a plurality of tuned transformers, and coherer circuits connected to the secondary of said transformers and characterised by relay circuits controlled by the coherers for operating circuit comprising sounder instruments.

2,701 Garin, M. V. Electro-deposition of copper and nickel from solutions obtained from ores. (27/2/16.) 104,675.
4,142 Ammentorp, C. Electric imitation candles. (20/5/16.) 106,609.
[illegible] (3/4/17.) 110,700
[illegible] (3/4/17.) 110,702
[illegible] & Harrison, H. H. Telegraph systems [illegible] 110,733.
11,236 Mason, C. T. Ignition dynamos. (15/9/16. 109,794.
[illegible] H. H. Telegraph systems [illegible]
[illegible] (22/8/17.) 111,072

Volunteer Notices.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Oxford-street, W. 1.

Orders for the Week.

Officer Commanding, Lieut.-Colonel C. B. Clay, V.D.

[illegible] Second Lieut. [illegible]
[illegible] and the range will be closed from [illegible]
[illegible] Parade at Headquarters, 2.45 p.m., for [illegible] and drill. Uniform to be worn.
[illegible] that one route march per month is compulsory.


OSRAM
OSRAM LAMPS

COMMERCIAL & INDUSTRIAL SECTION.

Control of Steel.

An Order has been made by the Ministry of Munitions amending the Order of the Minister of Munitions of Nov. 20, 1916, as to Control of Steel Supplies. By the new Order the provisions as to the control of certain classes of steel have been extended to steel in shell discard quality and steel made by electrical process. The Order, which is dated Dec. 14, may be cited as the Control of Steel Supplies (Amendment) Order, 1917.

* * * *

Commercial Intelligence Organisation.

It is officially announced that the new Joint Department of the Board of Trade and the Foreign Office, which is to undertake the future organisation of Commercial Intelligence, has now been constituted.

The new department will be known as the Department of Overseas Trade (Development and Intelligence). It will be represented in Parliament by Sir Arthur Steel-Maitland, M.P., who will occupy the position both of Additional Under-Secretary for Foreign Affairs and also of Additional Parliamentary Secretary at the Board of Trade. The Department will comprise the existing Department of Commercial Intelligence of the Board of Trade, including the management of the British Industries Fairs, the War Intelligence Trade Department, the section of the Foreign Trade Department of the Foreign Office dealing with Form K and with other matters relating to the promotion of trade abroad (the whole of the rest of the Foreign Trade Department will remain, as heretofore, under the controllership of Sir Ernest Pollock, K.C., M.P., at Lancaster House), and certain functions now performed at the Foreign Office in connection with commercial intelligence and with the Commercial Attaché and Consular Services. Sir William Clark, K.C.S.I., C.M.G., has been appointed Comptroller-General of the new department, and Mr. F. G. A. Butler, C.B., C.M.G., formerly of the Colonial Office, has been appointed director of the Overseas Division.

An Advisory Committee of Business Men to the new department is in process of formation, and will be announced shortly.

The temporary headquarters of the Department are at 73, Basinghall-street, E.C. 2, to which personal letters for Sir Arthur Steel-Maitland should be addressed. The Commercial Intelligence Staff will for the present continue to be housed at the same address. [illegible] Basinghall-street contains an inquiry bureau, where information on all matters affecting trade can be obtained on personal application, or inquiries can be addressed there either by post or telephone (Telephone Nos., London Wall 4713 and 4771). The War Trade Intelligence Staff will remain in their existing offices in Lake Buildings, S.W. 1.

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Controlled Firms and Advertising.

In our issue of November 30th we commented upon a suggestion made by the Ministry of Munitions as to limiting expenditure on advertising. The London correspondent of the "Glasgow Herald" now states that he is in a position to give an authoritative denial to the allegation that the Contracts Finance Department seeks to limit the allowance for advertising to one-fifth of the pre-war standard, on the ground that advertising expenditure to alter the war purposes is a charge to be met out of profits, and is not part of the manufacturing cost. We are glad to learn from our contemporary that "no such principle has been laid down, and that in dealing with the accounts of controlled firms for the purposes of the excess profits levy the Ministry of Munitions has already been ready to allow a reasonable advertising expenditure as a necessary condition to the carrying on of the business." [illegible]

* * * *

Co-operation in Trades.

At the luncheon of the British Empire Producers' Organisation on Thursday last, Sir A. Steel-Maitland, Director of the New Joint Trade Intelligence Department, referred to the attempts made in Germany to compel manufacturers in various industries to form associations for export trade after the war.

[illegible]

intelligible. One essential feature was close co-operation between industry and finance. On the proposal put forward for the establishment of an Imperial Bank of Industry he would not venture to pronounce a judgment, for he had not been through it in detail. What was really important was that somehow there ought to be, from the point of view of export trade, closer association between industry and finance. He proposed to obtain the advice and co-operation of those whose business was with banking and finance; it would be for them to indicate the functions and limitations of a Government Department.

It was for the Department to see that the commercial attaché service was constituted to effect its primary purpose, but in the new development it was for business men to co-operate. The Trade Commissions Service had started from a comparatively small beginning; there were now 16 Commissions throughout the Empire and the selections would, he trusted, produce closer commercial relations between the Dominions and this country. We had potentialities of growth in the Dominions and the great Crown Colonies which it was the aim of the organisation to promote, and the possibilities were immense. As to commercial attachés, it was right that their first endeavour should be to the promotion of British trade.

* * * *

Import Trade of Australia.

In a report on the position of the import trade of Australia in July last, Mr. G. T. Milne, H.M. Trade Commissioner in Australia, states that if the position of the United Kingdom in the export trade of the world during recent years has not advanced so rapidly as that of, say, Germany, the explanation must be sought not alone in the methods of production of goods, but also in the method of their distribution.

Many Australian firms have their own houses in London, and a still larger number have their buying agents in London and the provinces, and it is through these that the British and a large proportion of the Continental goods reach the Australian market. The foreign manufacturer takes care to be represented on the spot, and seeks orders direct from the Australian buyer. More than half the imports of German goods prior to the war, and almost the whole of the imports of Swiss, French and Belgian goods, passed through [illegible]. The buying agent in the United Kingdom of the Australian house does not make active propaganda in favour of the manufacturer, and it is only through a close study of market conditions by someone actively representing the manufacturer in Australia that the manufacturer will be placed in possession of information to enable him to modify his policy.

The manufacturer depending exclusively on the buying agent in the United Kingdom runs the risk that his connection may be tapped at its source, and even cut without his being aware of it. The firm with a branch house, or a representative, or a [illegible] stock, is in a better position than its competitor which is either not represented at all, or, if so, in such a way that the business is of an indent kind only. In regard to probable developments in which engineering supplies will be in demand, and to the representation of engineering firms, [illegible] expenditure on public and private works, demanding engineering plant and supplies.

Schemes for the extension of railways, electric power supply, &c., [illegible]

[illegible] turers are to meet [illegible]

ELECTRICITY SUPPLY.

EXTENSIONS.

Battersea (London).—At last week's meeting the L.C.C. authorised the Borough Council to borrow a sum not exceeding £37,555 for a turbo-alternator, converter, &c., for the electricity department, the amount to be repaid within 15 years.

Blackburn.—A report by the borough electrical engineer (Mr. P. P. Wheelwright), on the question of the erection of a new generating station at Whitebirk, has been referred to a sub-committee of the Electricity Committee for consideration.

Bootle.—Last week the Corporation approved an amended scheme of the Electricity Committee for putting down additional plant at the electricity works, and for extensions of mains, &c., at a total estimated cost of £80,000.

Braintree.—The Urban Council have passed plans of the new power station of the Crittall Mfg. Co.

Hackney (London).—The Electricity Committee report that the electricity supply undertaking is developing much more rapidly than was anticipated.

Daily maximum loads are now being experienced reaching between 7,000 kw. and 8,000 kw. The total plant installed has a capacity of 12,200 kw., but the largest set is 5,000 kw., and in the event of the temporary failure of this set they would be left with only 7,200 kw.—that is to say, 3,000 kw. of a.c. and 4,200 d.c. plant. The a.c. requirements exceed 3,000 kw., and it is not possible to deal satisfactorily with the transmission of the 4,200 kw. d.c. along the old pressure feeder mains. On Nov. 15 there was a failure of the 5,000 kw. set, the results of which were reflected in a serious curtailing of the supply to large consumers within the borough extending from Nov. 15 to Dec. 3. The borough electrical engineer has discussed the matter thoroughly with the Technical Director of Electric Power Supply at the Ministry of Munitions, and as the Committee are advised that they would be taking an undue risk if they delayed the installation of additional plant, they instructed the borough electrical engineer (Mr. L. L. Robinson) to find out what plant is more or less under construction for stock, and which can be delivered in time for next winter's maximum load. Mr. Robinson is now considering offers from Messrs. Willans & Robinson, the British Thomson-Houston Co., Messrs. Fraser & Chalmers, C. A. Parsons & Co. and the British Westinghouse Co. for plant, and from Messrs. Ferranti Limited for the switchgear, to which must be added a provisional sum for cable connections and foundations.

The Committee are to be authorised to place the necessary orders with the firms whose offers appear to be the most acceptable, and to incur an expenditure for the work up to £40,000. A loan of £28,000 is to be raised for Babcock & Wilcox boilers, water softening plant, &c.

Luton.—The Council are to consider a report from the electrical engineer (Mr. W. H. Cooke) on the urgent need for extending the station buildings, and providing additional generating plant, &c., to meet the increasing and prospective demand for electricity.

Swansea.—Application is to be made to the Local Government Board for sanction to borrow £42,000 for extensions of the electricity undertaking.

Stretford.—The Council has secured the option on a site at the junction of Chester and Trafford roads for a sub-station.

GENERAL.

Batley.—The Council recently agreed to increase the salary of the engineer of the electricity works, Mr. S. Derwent Jones.

Cheap Electricity and Industrial Development.—At the meeting of the Nottingham Chamber of Commerce last week the chairman (Mr. W. H. Blackburn) drew attention to the resolution on the subject of electricity passed by the City Council.

The matter, he said, came before the Advisory Committee of the Chamber at the last meeting. [illegible] of electricity [illegible] had been one of the greatest obstacles to the bringing of new industries to Nottingham, and there would have to be a change in those directions before [illegible] could hope to attract new trades here. He moved a resolution [illegible] the Chamber [illegible] of the supreme importance of a [illegible] general system for the economic utilisation of the coal of the country, and of the necessity for the production and distribution of cheap electricity if the industries of the city were to be maintained and developed, [illegible] support the City Council in its efforts to secure the adoption of Nottingham as one of the chief centres for the generation and distribution of electricity. The resolution was unanimously adopted.

Electricity and National Welfare.—The second of the Chadwick lectures at Leicester was given by Prof. H. T. Davidge on the 24th inst., the title being "Electricity and Increased Food Production." The lecturer pointed out the necessity for increasing plant growth by [illegible]. Various methods of "Electro-culture" were explained [illegible] were given indicating that great increases may be [illegible] possible in this way, but the lecturer indicated that further accurate [illegible] research was necessary before hard-and-fast rules could be formulated. Imported nitrates were expensive and involved shipping, hence nitrate manures must be made at home in future. The fixation of atmospheric nitrogen was explained and statistics were given showing the growth of the industry. The importance of cheap power was emphasised, and it was made clear that a load of the necessary kind was admirable to level up the load-factor of large power stations near coal and water. Lastly, under a scheme of high pressure electric supply net works extending over large tracts of the country, it was clear that the farmer of the future could tap cheap power for all farm purposes, including haulage and transport.

In the third lecture on Dec. 1, Prof. Davidge dealt with "Electricity and the Hygiene of the Body." He distinguished between safe and dangerous voltages and showed the effect of frequency of alternation. An explanation of the harmlessness of very high frequency high voltage current then followed. The use of X-rays for examination and curative treatment was then discussed and a simple explanation of the generation and action of these rays was given. Having explained in a simple way the various electrical terms employed by electro-medical specialists, the principles and uses of ionic medication were dealt with in detail; next followed the uses of the brush discharge and of electric baths. Applications of electricity and magnetism to the removal of foreign bodies from wounds were then dealt with and finally an elementary treatment of the properties and uses of radium for medical purposes was given. The lecturer called attention to the rapid strides made lately in electrical treatment, described the usual outfit of a first-class hospital and indicated what might be looked for in the future. The lecturer concluded by expressing the hope that all those who had so enthusiastically followed the three lectures would do their best in the future to assist in the application of the principles inculcated. A group of slides left over from the second lecture showing the application of electricity to farm purposes and kindly lent by Mr. Kerr, of Hereford, was then shown, and other slides followed, illustrating the generation and use of X-rays, ionic medication, diathermy and radium.

An enthusiastic vote of thanks to the lecturer and to the Chadwick Trustees was carried and the hope was expressed by those present that in the future the people of Leicester might look forward to another course. Inquiries respecting future courses of Chadwick Lectures should be referred to the Secretary at the Offices of the Trust, 40 (6), Queen Anne's-chambers, Westminster.

Felixstowe.—The Council is considering the question of taking over the local electricity works.

The agreement with the existing company was for 25 years, from Nov. 11, 1904, at the end of which the company was to hand over the undertaking. In the meantime, with the sanction of the Local Government Board, the Council had to provide the capital required for extensions. If the Council take over the undertaking at the end of 15 years it will have to pay the Company $2\frac{1}{2}$ per cent. per annum in respect of the unexpired 10 years on the capital provided by the Council to December, 1919. Up to date the Council has provided £30,000.

The Council's consulting engineer is to report on the matter.

Gloucestershire Electric Power Bill.—Newnham Council wi[ll] support the Bill to revive the powers of the Gloucester Electr[ic] Power Co., which were originally granted in 1902. It is, howeve[r], proposed to oppose the scheme in order to watch local interest[s]. The company's power station will be at Bullo Pill, an importa[nt] railway junction.

Sheffield.—In moving the adoption of the minutes of the Electr[ic] Lighting Committee at the meeting of the Corporation last wee[k], Councillor F. A. Warlow referred to the negotiations regarding t[he] supply of electricity to Sheffield, Rotherham and adjacent area[s]. He said the Ministry of Munitions were of opinion that not only w[as] there need for a considerable extension of the supply of electric pow[er] in the district for war purposes, but also for the needs of the coun[try] after the war. Sir Arthur Duckham, who represented the Minist[ry], had visited Sheffield on the question. Primarily, the proposal was t[hat] Sheffield and Rotherham should be linked together, and that propo[sal] had been willingly accepted on behalf of Sheffield, so that each und[er]taking, when it had a surplus supply of power, might sell to the oth[er]. The proposal of the Ministry also contemplated an extension of po[wer] stations, and negotiations on that question were in progress. Hav[ing] regard to the magnitude of the question and its importance to the tr[ade] of the city, Sheffield manufacturers, who were large consumers of e[lec]tricity, had been called into consultation, and were giving valu[able] assistance to the Electric Supply Committee. The question had [not] reached the point at which a definite statement could be made, bu[t] soon as any definite proposal was formulated it would be submitted [to] the Council for approval.

The following increases of salary have been approved by [the] Establishment Committee of the City Council in connection [with] the new power house.

Mr. J. R. Williams, assistant station superintendent, Kelham Isl[and], to be resident constructional engineer at a salary of £275 (including £2[5] increase); Mr. J. Newton, shift engineer, Kelham Island, to be assi[stant] station superintendent at a salary of £225 (including £25 increase), [ris]ing to £250 in 12 months; E. Atkinson, shift engineer, Neepsend, [to be] assistant station superintendent at a salary of £250 (including £[50] increase).

Stepney (London).—The report of the Electric Supply Committee submitted to the Council last week gave the following details of the development of the electricity undertaking:—

The maximum load during the year ended Nov. 17, 1917, was equal to 345,833 30 watt lamps, compared with 329,133 in the previous year. The capacity of the plant is 590,667. Units sold were 18,265,369 (against 19,635,660), including 2,796,790 (4,228,922) in bulk supplies to Poplar, Shoreditch and Bethnal Green.

The Committee also submitted an abstract of the accounts for the year ended March 31 last, which showed that the capital expenditure was £674,281, of which £493,606 was outstanding. Revenue was £139,081 and expenditure, including interest and repayment of loans (£46,518), was £142,665, the net result being a deficiency of £3,584. It is believed that the income of the current year will approximately meet all expenses.

Walthamstow.—The Urban Council has granted the following increases of salaries to officials in the electricity department:—

Mr. G. J. Hollyer £35 per annum and Mr. T. F. Lymn £25 per annum without bonuses; Mr. G. W. Stubbings £10 per annum with bonuses; Mr. W. H. Arnold £10 per annum.

Workhouse Lighting.—Mallow Rural Council have instructed their engineer to report on a proposal to adopt electric lighting at the workhouse.

LIGHTING AND INDUSTRIAL POWER.

A Large Electric Furnace. The "Iron Age," of New York, states that the largest electric steel furnace operating in the world is a 20-ton Héroult furnace from which as much as 27 to 30 tons has been tapped.

The furnace, which is at the Duquesne plant of the Carnegie Steel Co., began working in November, 1916. It requires 175 kw.-hours per ton of steel, and operates basic or hot metal. There are three electrodes of 12 in. graphite and the electrode consumption is now from 3 lb. to 4 lb. per ton of steel. The current is three phase, received at 6,600 volts, and is transferred to 100 volts at the furnace. Six heats are made per day of 24 hours, and each heat averages about 2½ hours.

Electric Furnaces in Canada.—At the recent annual meeting of the Commission of Conservation, the chairman (Sir Clifford Sifton) stated that there were now in Canada 32 Heroult furnaces for electric smelting, in addition to 22 electric furnaces of other types. The total annual smelting capacity of the 54 furnaces was 173,000 tons of iron and steel, 50,000 tons of ferro-silicon, and 8,000 tons of other ferro-alloys.

Electric Pumping Plant.—Worcester Corporation have applied to the Local Government Board for sanction to a loan of £4,400 for improvements at the waterworks, including the purchase of a set of electrically driven pumps with accessories, at an estimated cost of £1,400, and the laying of an electric supply main from Hylton-road works to the waterworks, at an estimated cost of £3,000.

Poor Law Institution Lighting. Cavan Guardians are to consider a report by their electrical engineer (Mr. P. J. [illegible]) regarding certain electric lighting plant conditionally purchased for the Board at £310.

ELECTRIC TRACTION.

Belfast. In moving the minutes of the Tramways and Electricity Committee at the last meeting of the Corporation, Ald. Ferrell referred to the two arbitration awards made by the Committee on Production.

The first award was in respect to the difference between the Committee and the Electrical Trades Union as to the status of the men employed in connection with overhead electrical equipment, and the second in respect of the claim of the tramway men belonging to the National Amalgamated Union of Labour for an increase of 3s. a week in war bonus. He said the first award established a principle the importance of which could hardly be overstated, for it was virtually whether the Corporation had a right to direct its own policy, do its own work, and institute, where it thought proper, reforms and retrenchments in the interests of the ratepayers, or whether an outside body in no way responsible to the ratepayers and having no interest in the city, had a right to dictate the Corporation's policy. The award was given in favour of the Corporation and the result would be that they were able to [illegible]. Hitherto they had about 30 men engaged in maintaining the overhead equipment. In future they would require only about 15 men, and would save between £30 and £40 a week in wages.

Christmas Tramcar Traffic. As the result of a ballot, the Bolton tramway employees have decided to cease work on Christmas Day. A similar decision has been arrived at by the Manchester employees, but they will run a service for munition workers.

Burnley Tramways Committee recently declined to accede to the application of the tramway employees to suspend the service on Christmas Day. The employees have now decided by ballot in favour of ceasing work on that day.

Dublin.—Last week the Electric Supply Committee unanimously recommended the Council to grant the members of the technical staff of the electricity supply department the award of the Committee on Production, which has been already granted to the skilled mechanics.

A notice of motion in favour of the recommendation was rejected. The technical staff have sent a letter to the Lord Mayor applying for arbitration within 14 days from the 10th inst.

Halifax.—Last week the Corporation decided to purchase two railless cars from Dundee Corporation at £1,250.

Ald. BROOKSBANK, chairman of the Highways Committee, moved to refer back the proposal, and said that whereas the cost of roads at Halifax was £140 per mile per year, the cost of roads on which trackless cars were run was £600 per mile. He understood that these cars had been withdrawn from running at Dundee because of the damage to the roads.

Ald. SPENCER, chairman of the Tramways Committee, said the proposal would save wear and tear of the roads rather than otherwise if the cars were run only on roads paved with setts. The Corporation might have to go in for goods carrying, and as each of the cars would carry 5 tons of material at a time their use for that purpose would relieve the roads of a number of heavy carts. Overhead copper wires would not be required. The cars would be fitted with accumulators, which would enable a car to run from 5 to 10 miles from the existing tramway wires. The total cost of the cars and equipment would be £1,900. Railless cars had a great advantage over petrol-driven vehicles. With petrol at 4s. 6d. per gallon, petrol vehicles would cost nearly twice as much to run. Besides, very few motor vehicles could mount the hills of Halifax with a 5-ton load. He believed that railless cars would become one of the most satisfactory and economical means of goods carrying in the future. It was quite possible that after the war, in the interests of national economy, there would have to be general legislation empowering municipalities and other tramway owners to carry goods. During the war it had been shown that local authorities could do some things as well, if not better, than the railway companies, and the day was past when railway companies were able to secure protecting clauses in municipal or private Bills. Neither should horse owners be specially considered as a section of the community, but what was the best for the town should be done. Leeds and Bradford Corporations were carrying goods that way, and if Halifax did not want those cars a neighbouring Corporation was willing to take them. He agreed that railless cars and motor omnibuses considerably increased the cost of road maintenance, but their effect on granite or stone setts was not appreciably different from that of other vehicles.

Kirkcaldy.—The Electric Lighting & Tramway Committee has refused an application of the employees through their Union for a reduction in the working week from 60 to 54 hours per week, and that they be paid time and half for overtime.

L.C.C. Tramways.—At the meeting of the London County Council on Tuesday the Highways Committee submitted a lengthy report dealing with the re-organisation of the tramways department, so far as it affects the electrical branch of the undertaking.

In May last Mr. L. P. Riviere was appointed electrical engineer, and subsequently promotions were made to the new positions of heads of sections, viz., power station engineer and distribution engineers for the southern and northern sections respectively. After careful consideration of a report of the electrical branch by the special sub-committee on tramway organisation, of which Mr. [illegible] was chairman, the Committee now submitted proposals for the appointment of an assistant electrical engineer and for the settlement of [illegible] not covered by the main scheme. Dealing first with the [illegible] of the officer, the Committee stated that they considered that an assistant electrical engineer should be appointed as soon as possible, as at present the work of the branch was seriously handicapped [illegible]. This officer should be able, as far as possible, to give his whole attention to important engineering questions, without being too much hampered with other routine work, and he should be competent to take charge of the branch in the absence of the electrical engineer. They thought that the salary of the position should be [illegible]

[illegible] the running of the plant and in consumption of fuel could be effected. In particular the electrical engineer informed them that the efficiency figure for coal could be raised considerably, and, bearing in mind that every 1 per cent. increase in efficiency represents a saving of £2,000 a year, he had no hesitation in assuring them that financial results would be achieved outweighing by far the cost of the proposed additions to the establishment. They proposed that the second position at the station should be that of assistant power station engineer (salary from £400 by annual increments of £20 to £500 a year), whose time should be devoted to as far as possible the economical running of the station. They proposed that Mr. J. R. Walker, senior charge engineer, be promoted to the position of assistant power station engineer. The superintendence and maintenance of repairs to turbines, generators, switchgear, &c., had occupied almost the entire time of the senior charge engineer. This work was most important and had been satisfactorily carried out at Greenwich, but upon the position of senior charge engineer becoming vacant, on Mr. Walker's promotion, they thought that the position should be abolished and that an engineer, with the designation of repairs superintendent, should be appointed to take charge of the whole of the repair work elsewhere than in the boiler house. They were advised that it would be preferable for one engineer to have charge of the repairs work. It would be difficult to find a suitable repairs superintendent until after the war, so that no immediate steps should be taken to fill the position. The salary to be assigned to the position should be from £300 by annual increments of £20 to £400 a year. As about 80 per cent. of the generating cost was represented by the cost of coal the staffing and organisation of the work at the boiler house called for and was receiving the most careful consideration. They were advised that the supervision of the boiler house should be re-arranged and investigations carried out, this course involving the appointment of an additional charge shift engineer (£250, by annual increments of £10 to £300 a year). To fill the additional position of charge shift engineer they recommended the appointment of Mr. R. Thompsen, one of the candidates recently seen by them when making a selection for a vacant position of charge shift engineer. There was at present a lack of proper supervision in the sub-stations owing to shortage of staff, and, as in the case of the power station, the engineers had been compelled owing to the pressure of urgent and routine work to neglect seriously the very [illegible]. The difficulties of the heads of the north and south sections (the distribution engineers) had been much increased by the numerous breakdowns of cables and the want of motor vehicles necessary to enable them to keep in touch with their sub-stations and other work over the large areas covered. They therefore proposed [illegible] section for one position in the second class and one position in the third [illegible] saving in the working costs of the undertaking under normal conditions; [illegible]

Post Office London Railway. [illegible]

Wigan. [illegible]

TELEGRAPHY AND TELEPHONY.

[illegible]

Automatic Telephony in Australia.—The automatic telephone exchange, which is to be erected in Sydney, N.S.W., will cost between £80,000 and £90,000. There will be two exchanges, one in Sydney North and Sydney South. The first will carry 20,000 lines, and when full the second will be established.

Japanese Wireless Station.—It is stated that a wireless station as large and as well equipped as the Naval Station at Funabasi, is to be erected at Sushu, in Formosa. It is intended to be one of the largest stations in the world.

Radiotelegraphy on Spanish Ships.—A Royal Order issued by the Spanish Ministry of Marine on Oct. 19 is to the effect that eight months from the publication of the Order every merchant vessel of 500 tons or upwards engaged in the coasting trade of Spain must carry a complete wireless telegraph installation on board.

South American Wireless Stations.—The "Review of the River Plate" recently announced that a new radiographic station, erected by the Ministry of Marine at San Julian (Territory of Santa Cruz), was opened on Nov. 20.

This station has a range of about 310 miles. Another wireless station is to be erected at Punta Delgada and will complete the chain of stations on the Patagonian coast. The aerial of this station will be supported upon the lighthouse, and its range will also be 310 miles. It is expected to be ready for service by the end of February.

U.S.A. War Cablegrams.—It is announced that until the end of the war the Eastern Telegraph Co. will charge half the ordinary cable rates for all United States Government telegrams passing over any part of its system.

Wireless Telegraphy between Holland and Dutch Indies.—The Dutch Government have asked for a credit of 5,000,000 florins for establishing radio-telegraphic communication between Holland and the Dutch Indies. The contract has been secured by the Gesellschaft für Drahtlose Telegraphic, of Berlin. The receiving station will be ready in 3 months and the sending in 18 months.

MISCELLANEOUS.

Electric Light Switching.—From Messrs. A. P. Lundberg & Sons 477-489, Liverpool-road, London, N.7, we have received a copy of a new preliminary grade examination Paper in this subject, and we may mention that anyone can obtain a copy on application, together with other particulars regarding these free home examinations.

The Paper itself includes a set of rules for the guidance of examinees, and the new set of 11 questions shows no falling off in practical and interesting points. Up to June last 637 examinees had gained the preliminary grade certificate, not to mention those holding intermediate and advanced awards.

Electrical Trades Benevolent Institution.—The Committee have received an appeal for donations to the amount of £300, which they are anxious to secure by the end of the year to enable the Institution's invested funds to be increased to £10,000. Mr. A. Campbell Swinton gave £100 for this object at the last annual meeting, and Sir David Salomons has, in addition to his liberal annual contribution, contributed £20.

Royal Naval Air Service.—We have received a copy of an article and instructive brochure (published at the "Illustrated London News" Office at 2s 6d net) on "The Work and Training of the Royal Naval Air Service." It consists mainly of pictures, which give an idea of the methods of instruction in aeroplane construction, the use of firearms, wireless telegraphy, bomb dropping, &c. In addition to aeroplanes, views are included of kite balloons, balloon and seaplane carrying ships, &c. The book will doubtless stimulate recruiting for the Naval Air Service.

Trading with the Enemy.—The "London Gazette" of Dec. 7 contained further additions to the Statutory List of firms and persons with whom trading by firms and persons in the United Kingdom is prohibited.

These include the following:—*Argentina*, Compania Alemana Transatlantica de Electricidad (Buenos Ayres), Deutsche Ueberseeische Elektricitats Gesellschaft (Buenos Ayres).

Exports.—The exports of electrical machinery, material, &c., (a) during October 1916, and (b) from Jan. 1 to Oct. 31, with increase or decrease compared with corresponding periods of 1916, were as follows:—

[illegible] £128,678 (decrease £5,113), (b) £1,237,230 [illegible] including railway and tramway motors, (a) £5,880 [illegible] (b) £30,826 (decrease £2,383); other generators and [illegible] (a) £19,9[illegible] (decrease [illegible]) [illegible] (increase £33,608); and electrical machinery unenumerated [illegible] (increase £5,812), (b) £191,813 (decrease £13,102); telegraph and telephone cables, submarine, (a) £13,437 (increase £20,949) [illegible] other than submarine, (a) £22,186 (decrease [illegible]) (increase £122,088); telegraph and telephone apparatus [illegible] (increase £11,380), (b) £228,813 (increase £18,624);

other electrical wires and cables, rubber insulated, (a) £5,066 (decrease £50,355), (b) £173,244 (decrease £308,088); with other insulation, (a) £6,328 (decrease £43,363), (b) £252,822 (decrease £429,547) carbons, (a) £565 (decrease £855), (b) £21,438 (increase £12,030); glow lamps, (a) £10,278 (decrease £6,857), (b) £112,914 (decrease £24,658); arc lamps and searchlights, (a) £57 (decrease £1,350), (b) £22,598 (increase £14,620); parts of arc lamps and searchlights (other than carbons), (a) £4,512 (increase £2,234), (b) £71,743 (increase £56,641); primary and secondary batteries, (a) £10,481 (decrease £9,679), (b) £130,569 (decrease £100,570); meters and measuring implements, (a) £11,853 (decrease £7,120), (b) £114,514 (decrease £63,889); transformers, (a) £6,291 (decrease £2,806) (b) £61,869 (decrease £25,796); switchboards, (a) £2,643 (decrease £3,097), (b) £32,589 (decrease £18,769); electrical goods and apparatus unenumerated, (a) £65,214 (decrease £23,724), (b) £598,523 (decrease £4,048). Total of electrical goods and apparatus other than machinery and uninsulated wire, (a) £216,687 (decrease £148,101), (b) £2,555,685 (decrease £12,177).

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (a) during October, 1917, and (b) the aggregate figures from Jan. 1 to Oct. 31, with increase or decrease compared with corresponding periods of 1916:—

Electrical machinery, (a) £113,203 (increase £61,624), (b) £1,160,503 (increase £195,419); including generators and motors other than for aeroplanes, motor cars and cycles, (a) £15,218 (decrease £1,095), (b) £204,621 (increase £22,550); and electrical machinery unenumerated, (a) £97,985 (increase £62,719), (b) £955,882 (increase £172,869); telegraph and telephone cables other than submarine, (a) £65 (decrease £10,640), (b) £50,587 (decrease £20,362); telegraph and telephone apparatus, (a) £1,125 (decrease £4,212), (b) £25,986 (decrease £186,049); other electrical wires and cables, rubber insulated, (a) £1,538 (decrease £13,636), (b) £33,301 (decrease £73,680); with other insulations, (a) £211 (decrease £1,453), (b) £8,861 (decrease £5,327); carbons, (a) £3,098 (decrease £3,211), (b) £65,844 (decrease £7,901); glow lamps, (a) £6,083 (decrease £16,379), (b) £71,890 (decrease £171,219); arc lamps and electric searchlights, (a) nil, (b) £97 (increase £97); parts of arc lamps and searchlights (other than carbons), (a) £10,680 (decrease £1,211), (b) £102,459 (increase £10,009); primary and secondary batteries, (a) £30,107 (increase £11,845), (b) £62,808 [illegible]; meters and measuring instruments, (a) £4,588 (increase £53), (b) £30,198 (decrease £13,841); switchboards, (a) £80 (increase £80), (b) £561 (increase £304); electrical goods and apparatus unenumerated, (a) £53,697 (increase £14,470), (b) £459,548 (increase £157,756). Total of electrical goods and apparatus other than machinery and uninsulated wire, (a) £111,272 (decrease £24,294), (b) £1,112,110 (decrease £214,249).

TENDERS INVITED AND ACCEPTED.

Turbo-Alternator with Condensing Plant.

The Electricity Committee of Bolton Corporation invite tenders for the supply, delivery and erection of a 7,500 kw. Turbo alternator, with condensing plant. Specification and form of tender from Mr. W. J. H. Wood, borough electrical engineer, Back o' the Bank, Bolton. Tenders to the town clerk, Mr. Samuel Parker, Town Hall, Bolton, by noon, Jan. 15. *See advertisement.*

Battery, &c.

Tipperary Guardians require tenders by [illegible] Jan. 11 for the supply of a new Battery [illegible] with the electric lighting plant and for overhauling [illegible]. Specification from Mr. [illegible], Dublin.

Telephone Service.

[illegible] Municipality recently invited tenders which are to be opened on Feb. 27, for the provision of telephone service within the district of the municipality.

[illegible]

APPOINTMENTS VACANT AND FILLED.

[illegible]

One or more full-time teachers of technical electricity, electrical engineering and wiremen's work are wanted for the day classes for training disabled soldiers at Leeds Technical School. *See advertisement.*

Mr. G. Wren and Mr. S. H. Holding have been appointed assistant superintendents of telegraph engineering in the Indian Public Works Department.

BUSINESS ITEMS.

Owing to their offices having been requisitioned by the Government, Messrs. Robert W. Blackwell & Co., Ltd., have removed to 36, Emperor's-gate, South Kensington, London, S.W. 7. Telegrams: Kurkee Southkens London; Telephones: Western 4362-3-4.

Advance of Prices.—The Benjamin Electric (Ltd.), 1a, Rosebery-avenue, London, E.C.1, announce that, owing to increasing cost of labour and materials, a further advance of 10 per cent. has been made on all their lines as from 18th inst., making a total increase of 20 per cent.

Plant for Sale.—The City of Leeds electricity department advertise for sale some engines, alternators and condensing plant. The plant is in good working order, and is being removed to make room for larger sets. Offers to the manager (Mr. C. Nelson Hefford), Electricity Department, 1, Whitehall-road, Leeds.

Patent Development.—The owner of patent No. 28,630 1913, relating to "electrolytic converter for the transformation of alternating currents into continuous currents" wishes to enter into arrangements for working the invention. Particulars from Messrs. Allison Bros., 84-86, Chancery-lane, London, W.C. 2.

Application for Extension of Patent.—Notice is given that Sir James Dewar, F.R.S., LL.D., intends to present a petition to the High Court on Jan. 15 for an extension of the term of the Letters Patent No. 13,638, 1904 granted to him for "An improved method of absorbing gases and the application thereof in the production of high vacua and the separation of gases." Messrs. J. H. & J. V. Johnson, 47, Lincoln's Inn Fields, London, W.C. 2, are solicitors for the petitioner.

LIQUIDATIONS.

The High Power Gas Engine Co. (Ltd.) is being wound up voluntarily, and Mr. F. G. Pann has been appointed liquidator. A meeting of creditors will take place at the company's registered office, Moorgate Hall, London, E.C., on Dec. 21.

The Edison Mfg. Co. (Ltd.) is being wound up voluntarily, and Mr. A. F. Wagner, 164, Wardour-street, London, W.1, has been appointed liquidator. A meeting of creditors will be held at 164, Wardour-street, on Dec. 28.

CATALOGUES.

Lamp and Wiring Supplies.—We have received a copy of one of the excellently prepared lists of the lamp and wiring supplies department of the British Thomson-Houston Co. (Ltd.), Mazda House, London, E.C. 4. This list, which extends to over 70 pages, relates entirely to wiring installation accessories, covering the standard types of such material as [illegible] wiring appliances, such as lamp holders, switches, wall plugs, ceiling roses, cut outs, distribution boards, [illegible] &c.

[illegible]

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

Edison Swan Electric Co. (Ltd.)

The thirty-fourth ordinary general meeting was held on Wednesday, Mr. Charles Jermyn Ford (chairman) presiding.

Mr. R. H. PARKER (the secretary) having read the notice convening the meeting and the report of the auditors.

The CHAIRMAN said: Gentlemen, the new capital, consisting of 100,000 preference shares of £1 each,was,as you are aware, duly issued in June last, shortly before the date of the balance-sheet, and at that date we had received in respect of this issue the sum of approximately £25,000, being the amount due on application and allotment and £35,000 payments made by shareholders in advance of calls, giving us a total sum of about £60,000. Loans, you will notice, stand at £44,000, against £27,000 at the date of the previous balance-sheet. The reserve account now stands at £40,000 against £15,000, bringing it almost up to the same figure at which it stood four years ago. Freehold and leasehold property stands at £74,900, against £73,500 previously. We have, in the period under review expended £3,402 on new buildings, and written off from this item as depreciation £2,000. This further expenditure has been mainly in respect of additions to the lamp works, and has made them more efficient and capable of a considerably increased output, and we shall possibly have to make a further considerable outlay on this part of the works.

The item of "Plant and Machinery" has also increased by £7,500 for the same reason. "Stocks" have risen to the extent of £315,000, which is mainly due to the enhanced cost of raw materials, coupled with the increased price of labour. "Sundry debtors" stand at £123,000, an increase of nearly £20,000, a large percentage of the total sum owing to us being in respect of Government contracts. At the first glance the results of the trading for the year may seem to you unsatisfactory, but I must remind you that during the past year the company has carried on its operations under probably the most disadvantageous circumstances which it could possibly have to face. It has been pointed out to you, at every annual meeting at which I have presided, that the need of additional working capital was very seriously prejudicing the company's position, rendering it unable to take full advantage of any increased trading which it might obtain, and for the last few years the position had become steadily worse in this respect, and during the year it arrived at its climax. I, therefore, think that the earnings disclosed cannot be a surprise to you. That portion of the new money brought in by the preference share issue, of which up to the date of the balance-sheet we had received about £60,000, was not at our disposal until practically a few days before the close of the financial year. Under these circumstances, of course, we received no practical benefit from the money in the period. This shortness of working capital has also affected us in two other ways, firstly, we have been unable to take full advantage of discounts on goods purchased, and I estimate that the losses under this head amount to somewhere [illegible] £5,000, and, secondly, we have not been able to purchase these goods as advantageously as we might have done. Then the profits which would, under normal conditions, have been earned at our branches abroad, have been seriously affected by the fact that it has been impossible to obtain shipping freights in order to keep these branches fully supplied with stock. I told you last year that we had increased our operations in our Colonies and that we were building up a good business there, but since then the question of shipping freights has become far more difficult than one could have foreseen. The profit from the manufacture of electric lamps has also suffered, partly from the rise in the cost of labour and materials and partly from the fact that a very large number of our old and skilled hands have left our works to take up the manufacture of munitions and we have been forced to fill their positions with unskilled hands. I am glad to say that this difficulty has, for the moment, been practically overcome, and the sale of lamps for the past six months has largely increased. The price of the lamp was only raised in May last, whereas during the whole period the costs of manufacture had increased by about 33 per cent. Generally speaking, we have been manufacturing [illegible] of our product under very difficult conditions. We quoted prices based upon current rates of labour and raw materials, adding such a percentage as we were able to against the contingency of higher prices for labour and raw materials which might come into force before the [illegible] [illegible].

In [illegible] [illegible] [illegible] [illegible]. Owing to war conditions and the heavy rise in all raw materials, a large amount of capital is required to run a business of this character, and, as our turnover [illegible] [illegible] [illegible] [illegible] [illegible]. The question of a small dividend payment [illegible] shares was the subject of a great deal of discussion, and the board naturally are anxious to recommend one directly they can [illegible]. Some of you may consider that, instead of carrying forward the sum of £13,200, we should apply a portion of it in payment of a small dividend upon the "A" shares, but we still owe the bank [illegible] £3,000 and it is incumbent upon us to reduce this as far as possible. We have over £7,000 to pay away shortly for munitions levy. On Jan. 1 there is the interest upon our first debenture stock to be met, which amounts to about £7,700, and on Feb. 1 there is the dividend upon the new preference shares, absorbing between £2,000 and £3,000. A dividend of only 2 per cent. upon the "A" shares would absorb £7,600, and therefore under these circumstances we have to go very closely into the cash position. We have suffered heavily during the last few years from the shortage of cash working capital, and now that we are getting into a better position it behoves us to be very careful that we do not run short again. For all these reasons, we feel that, as regards an immediate dividend, we must go a little slow, and we do not therefore see our way to recommend it at the present juncture. The new money has undoubtedly improved our position and earning capacity, and, with the very considerable increase in the output of lamps which we have now achieved, should make it possible for us, in the absence of unforeseen circumstances, to make a better showing for the current year. Practically the whole of the engineering side of the works has been, and is still, occupied with Government work. We have experienced a loss of profit of approximately £2,500 in consequence of our having received no dividend in the past year on our holding of deferred shares in Altrincham Electric supply. Some important contracts have been entered into for the supply of current for power purposes, and I am looking forward to far more satisfactory results for the current year. He concluded by moving the adoption of the report and accounts.

Mr. E. B. ELLICE-CLARK, in seconding the motion, said, in regard to the munitions levy, for which £7,295 had to be paid, the Board considered that it would not be too strong a term to say this was an unjustifiable levy on the Company. It was based upon pre-war profits. The company was for a few years before the war in very low water; in fact, in one year a loss was made, and in others the profit was negligible, but it was mulcted in a very heavy tax, which it could ill afford to meet.

The resolution was then put and carried unanimously.

Mr. C. Jermyn Ford (chairman) was re-elected a director, and the appointment of Mr. John Cross as a director was also confirmed. The auditors (Messrs. Broads, Paterson & Co.) were also re-appointed, and the meeting terminated.

An extraordinary general meeting was then held, and the following resolution, moved by the CHAIRMAN and seconded by Mr. ELLICE-CLARK, was carried unanimously: "With a view to carrying into effect the scheme of arrangement between the company and its debenture stock holders and members, the capital of the Company be reduced from £888,071 to £698,307 by extinguishing the liability of £2 on each of the partly paid "A" shares, the numbers whereof are set out below, and the holders of which have applied for and had allotted to them first preference shares in terms of the said scheme of arrangement."

A vote of thanks to the directors and staff terminated the proceedings.

FERRANTI (LTD.)—The annual general meeting will be held on the 28th inst. The directors regret that they are unable to submit the accounts for the year to June 30, 1917, as several important matters connection with the Company's contracts with the Ministry of Munitions have not yet been settled.

CITY NOTES.

BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. (LTD.)—Mr. F. Dudley Docker, C.B., has joined the board of this company.

CANADIAN GENERAL ELECTRIC CO. (LTD.)—A quarterly dividend of £2 per cent. on ordinary stock, payable Jan. 1 next, has been declared.

EAST LONDON RAILWAYS.—A dividend of 8s. 9d. per cent (less tax) has been declared on the B debenture stock for the past year.

EASTERN & ASSOCIATED TELEGRAPH COMPANIES.—Sir John Wolfe-Barry, owing to advanced age, has decided to relinquish his position as chairman of the Associated Companies, over which for many years he has presided; but the companies will continue to have the benefit of his services on their respective boards. Sir John Denison-Pender, K.C.,M.G., has been elected chairman in succession to Sir John Wolfe Barry.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.) The directors have declared a third quarterly interim dividend of 3s. per share (tax free) in respect of profits for the year ending Dec. 31 next, payable on Jan. 15, 1918. The share register will be closed from Jan. 7 to 14 inclusive.

RICHARDSONS, WESTGARTH & CO. (LTD.)—Meetings of (1) the preference shareholders and (2) the ordinary shareholders to consider a scheme of arrangement between the company and such shareholders are to be held at Hartlepool.

SPANISH & GENERAL WIRELESS TRUST.—The accounts for the year ended June 30 last show a loss of £393, reducing the balance to £903.

UNITED ELECTRIC TRAMWAYS CO. OF MONTEVIDEO (LTD.)—The directors announce that, having regard to abnormal freights and cost of coal and the uncertainty of the outlook in view of the conditions now existing, they have thought it desirable to postpone the declaration of an interim dividend on the preference share capital until the accounts for the year are available.

VICTORIA FALLS & TRANSVAAL POWER CO. (LTD.)—The net earnings (including those of the Rand Mines Power Supply Co.) for the quarter ended Sept. 30, amounted to £220,723 before providing for taxation in South Africa and Great Britain.

WESTERN UNION TELEGRAPH CO. (LTD.)—The directors have declared a quarterly dividend of 1½ per cent., with an extra dividend of 1 per cent.


Benjamin Lighting Specialities are in Universal Use
REG. TRADE MARK.
In the Dye Works.
THE Dye Industry has been, and still is one of Britain's great opportunities of the war. The monopoly which Germany enjoyed in this branch of Industrial Science is, we believe, a thing of the past, and we hope an unknown quantity in the future. As in most other captured industries of any importance, that of dye making calls for an unrestricted application of energy and science on the part of its chief promoters and exponents in this country to counterbalance the natural facilities of manufacture enjoyed by our rivals in the pre-war era, and it is a matter for congratulation that this concentration of brains and activities has already been the means of notable achievements in the right direction.
Naturally, the utmost efficiency in all conditions pertaining to the successful production of the dyes is absolutely necessary, and one of the most important of these conditions is LIGHT.
Realising this, we evolved a special range of Well-Glass Fittings, which, in addition to being vapour and fume-proof, were of high illuminating efficiency, and the large numbers which are installed throughout the country prove in a definite manner their superiority.
Other Specialities include Shock-proof Hand-Lamp Reflector Fittings, Semi-Indirect Fittings, Industrial Signals, etc., etc.
There is a Benjamin Speciality for every class of Installation.
THE
BENJAMIN ELECTRIC, Ltd.
ROSEBERY AVENUE,
LONDON, E.C. 1.
BENJAMIN WELL-GLASS FITTINGS are GAS-TIGHT and VAPOUR-PROOF.

THE ROUND TABLE.

By "kVA."

For the first time since its inception the Round Table was crowded out last week. The Editor went into such transport of delight over his Materials Handling Number that even the Unofficial Harmonic Programme did not find a place. However, I am including it this week for the benefit of those who were not at the concert.

* * * *

I have had numerous appreciations of our Big Issue last week, the shortest and quite the best is "Tres Benn!" From another source is a claim for compensation by a reader whose taxi broke down owing to the floor giving way with the weight of the issue! (Next, please!)

* * * *

Mr. Ernest R. Baerlocker, of Brown, Boveri & Co.'s standard department, writes me as follows from Baden, Switzerland:—

Dear Mr. kVA,

Could you, please, make up your mind and standardise your initials? Listen:

Capital is sorely needed in war, therefore you cannot spare any for your "k."

There was once a "Con[illegible]"
Which said "You only want k [illegible]
Did ever you hear
Of its symbols so clear?
Then go and abolish your "K"!

A HAPPY READER.

I am quite in agreement, and for the period of the war will economise capital in accordance with [illegible] "happy reader's" suggestion. It's now up to him to buy War Bonds!

* * * *

ELECTRO-HARMONIC SOCIETY.

SEASON 1917-18. THIRD CONCERT.

Unofficial Programme.

BY "kVA."

In the Chair, [illegible]

OPENING SKETCH "Another Little [illegible] wouldn't do us any Harm" . . . *R[illegible].*
COUNCIL INST. E.E.

DALE END QUINTETTE "At the Call of the Dawn" *Callendered.*
MR. HOWARD [illegible]

HIGH-PRICE GLEE "We didn't want to do it" *Ohno!*
TUNGSTEN LAMP ASSOCIATION.

TARIFF BALLAD "I'd like to [illegible] but [illegible]" *Gassed.*
[illegible]

POST WAR SOLO "[illegible]"
[illegible]

BALLOONETTE "[illegible]" . *Phew!*
[illegible]

SEXTETTE "[illegible]" *L[illegible]*
[illegible] LAMP CO.

ROUNDELAY "[illegible] Believe Me" *[illegible]*
MR. F. L. [illegible]

TRAFFORD PARK MEDLEY "[illegible] Game"
MR. [illegible]

GOD SAVE THE KING.

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN, December 18, 1880.]

ELECTRIC LIGHTS ON THE THAMES EMBANKMENT.—We recommend little boys not to congregate underneath the Jablochkoff lights as evening approaches. A [illegible] from one of these lamps the other evening on being first lit up and scattered the unsuspecting juveniles most incontinently.

THE P[illegible].—[illegible] the photophone is giving rise to many novel experiments and suggestions. A correspondent asks whether intermittent magnetic rays would not in all likelihood produce sound in a body upon which they are directed. He should try for himself. Some ingenuity will be needed to shut off the local noise occasioned by the act of interrupting.

BRITISH MUSEUM.—Last [illegible] one of the four Siemens lamps, which illuminate the reading room, after playing some vagaries, went out [illegible] for some little time, the readers in that part of the room being left in comparative obscurity. Such accidents are explainable and excusable: but to admit that they are unavoidable would be fatal to electric lighting. Every effort should therefore be [illegible] them impossible.

Transport Facilities.—[illegible] Monday [illegible] in view of the [illegible] United Kingdom, his attention [illegible] of the New Transport Co., and whether he proposed to take any action.

In reply Mr. W[illegible] company were put before the President [illegible] received on Nov. 23, and my right hon. friend pointed out that any inquiry with reference to the adoption of the Company's main scheme was, in his opinion, impracticable during the war. He offered, however, to consider a proposal which the Company had in mind to enable shipping at ports to be [illegible] a small committee [illegible]

Co-operation in the Brass Trade.—At the last meeting of the Birmingham section of the Institute of Metals Mr. Stanley Evered gave an address on [illegible] with special reference to the [illegible]

By co-operation, Mr. [illegible] manufacturing, [illegible] would enable [illegible] prices to meet foreign competition. He referred to the advantages of laboratories in the metal trades on the co-operative principle, and pointed to the success of [illegible] School by the [illegible] Ministry of Munitions and [illegible] own. He proposed [illegible] The Brass Trades [illegible] by the [illegible] all [illegible] would be circulated. When existing knowledge had been dealt with the [illegible] was [illegible] would be successful.

Southern Pacific Railway Electrification.—The first section of the [illegible]

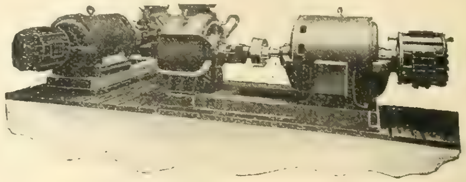
[illegible]

Large Generating Units in [illegible].—[illegible]

[illegible]

LARGE PUMPING SETS.

Some large pump sets have recently been supplied by the General Electric Co. to an allied Government, consisting of 228 H.P. and 354 H.P. "Witton" motors coupled to Rees Roturbo pumps. The motors were constructed to operate on a 500-volt 50-cycle circuit, and to run at 1,470 revs. per min., being direct coupled to the pumps. They are of the induction type with forced ventilation, and have their slip-rings enclosed in totally enclosed covers. The Rees

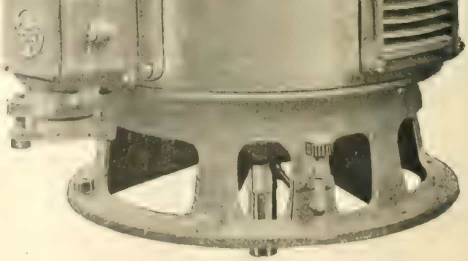


Roturbo pumps have a capacity of 15 cubic metres of water per minute when operating respectively against total heads of 45 and 70 metres. The units are mounted on combination bedplates, and are shown in the accompanying illustration. For starting purposes liquid starters were supplied. The equipment was provided by the General Electric Co., of Witton, Birmingham, and 67, Queen Victoria-street, E.C. 4.

VERTICAL SPINDLE INDUCTION MOTORS.

The British Thomson-Houston Co. (Ltd.), of Rugby, have recently issued list No. 2,180, dealing with vertical spindle induction motors. The motors described in the list have been specially designed for vertical direct-connected driving where two or three-phase alternating current is available; they are known as type IV. machines, and can be supplied in all sizes from $2\frac{1}{2}$ H.P. to 450 H.P. They are composed essentially of two parts.

(1) The stator or stationary part forming the frame of the motor and provided with a winding to suit the speed, and the number of phases, frequency and voltage of the supply circuit. (2) The rotor or revolving



part, which is secured to the vertical spindle and thus rotates with it. The rotor is provided with a winding which is not electrically connected either to the stator winding or to the supply circuit, and the current in the rotor is due only to the inductive effect of the stator. The rotor winding is either permanently short circuited or else connected to slip-rings mounted on, but insulated from, the shaft. B.T.H. machines with squirrel-cage rotors are known as "Form K" motors, while those with slip-rings are "Form M." Standard machines are designed for 40, 50 or 60-cycle circuits at 100, 200, 400 or 500 volts, and tables of limiting voltages, overload capacity, ratings, approximate dimensions and shipping specification are given. Our illustration shows a drip-proof vertical induction motor of 30 H.P. with a speed of 1,500 revs. per min., for a 250-volt 50-cycle circuit.

ECONOMY OF ELECTRIC TRUCK IN COAL HAULAGE.

Since the beginning of the year the Canton (Ill.) Gas & Electric Co. has employed an electric truck for hauling coal with very beneficial results.

The distance from the railway station to the company's electricity works is about three blocks, to the gas works about 1·5 miles. Over this distance the truck makes a round trip to the electric plant in about 7 minutes and can convey the contents of a 50-ton car of screenings to the station in about three hours. The round-trip haul to the gas plant requires about 30 minutes. The speed of the truck loaded is about 7 miles an hour, and in ordinary operation it will cover from 15 to 25 miles a day, depending on how many trips are made. The truck is a Walker Vehicle Co.'s design with 44 cells of 31-plate Philadelphia storage batteries. It is equipped with a Lee Loader dump body, which enables the driver alone through the use of it to unload 10,000 lb. of coal into the hopper in two minutes. The driver, who operates the truck exclusively, is responsible for its entire care, both as to charging and maintenance.

Data for Two Weeks.

Date	Hours out.	Stops.	Miles.	Road conditions.	Amp.-hrs. used.
Jan. 22	9	36	15	Good	180
23	9	38	22	Good	228
24	9	38	21	Good	222
25	9	36	28	Good	276
26	10	42	30	Good	300
27	9	26	19	Good	168
Total			135		
Average amp.-hours per mile					10·3
Jan. 29	9	12	13	Mud	180
30	10	18	26	Mud	444
31	9	22	16	Mud	340
Feb. 1	9	19	23	Rough	220
2	10	18	22	Rough	312
3	9	22	16	Rough	204
4	5	10	6	Snow	96
Total			122		
Average amp.-hours per mile					14

FREIGHT PROBLEM IN THE MEAT PACKING TRADE.

The transport question is a very important problem in the meat packing industry, and a recent issue of the "Electrical World" gives particulars of the successful attempts made by Messrs. Armour & Co. to solve it.

It is stated that the Armour Company handles within its 39 acres of plant in round numbers about 5,000,000 lb. of freight a day. Of this amount 2,000,000 lb. is attributable to inter-departmental handling and 3,000,000 lb. is handled from different departments, coolers or store rooms to loading platforms and railroad cars. The cost of labour for performing this huge task is about $500,000 annually. In 1893 the company erected an elevated electric railroad at a cost of $75,000. This railroad, connecting all manufacturing departments with each other and with the main shipping points, comprised 7·5 miles of track. It was equipped with 2 miles of overhead trolley, seven motor cars with 15 H.P. motors, and 950 three-wheeled trailers, weighing from 600 lb. to 700 lb. empty.

Formerly the freight, which consists of finished products, such as canned goods, soaps, fresh meats, lard, eggs, butter, &c., was hauled on the elevated road from the departments to a central point known as the packing and shipping department. This freight, which amounted to 200,000 tons a year, comes into the central department at the third floor level. There it was unloaded from the trailers, was hauled on two-wheeled trucks to the first floor, re-grouped in carload lots, and then again handled on two-wheeled trucks into outgoing railroad cars. This was considered an inefficient procedure, and tests were made to determine a better method than that of the two-wheeled truck, since it was established that 300 lb. was a good average load for one man to handle in this manner. Four-wheeled ball-bearing push trucks measuring 5 ft. by 2·5 ft., and weighing 250 lb., were tried, as were also storage-battery driven industrial trucks. It was found that one man could handle 1,000 lb. on a push truck and about twice that on the storage-battery truck. But in the packing and shipping department it was decided that it was necessary to have as many square feet of truck surface as was required for storing freight on the floor, if a saving was to be made between the operation of getting the freight off the elevated road and into the outgoing cars. It was estimated that this required about 1,000 trucks, thereby eliminating the storage-battery truck on account of the large investment. So the four-wheeled push trucks were chosen, and the change from the two-wheeled truck reduced the trucking cost 16·5 per cent. per ton.

The next logical step was to try handling these four-wheeled trucks as trailers behind storage-battery-driven tractors. This permitted the use of loads greater than 1,000 lb. on the trailers, which was not feasible with man power. Before the motor tractors were tried the work in the packing and shipping department was carried out by from eight to ten loading gangs, each of which consisted of two checkers, four carmen, four truckers and one loader. The tractors made it possible to displace in each gang the four men used as truckers by rearranging the [illegible] of

the men. It was then possible to haul as many as 10 or 12 trailers behind each tractor, taking as much as 5 or 6 tons per tractor load. This change reduced trucking costs 25 per cent. per ton. Finally, storage-battery tractors were tried out in competition with the elevated railroad. A section of the road was shut down, and freight on that section was handled by two tractors and a group of four-wheeled trailers. Two railway motor cars were displaced. This change was easily effected, as the tractor could operate on the board walks alongside the elevated tracks. Records showed that during the two weeks' test period the tractors handled 27 per cent. of the freight transferred over the elevated railroad at 16 per cent. less cost than it could have been handled by the hand truck and elevated motor method; but it is believed that a better showing could be made if the rails were covered to give a broader and unbroken dock surface. That it was possible to make such a saving is attributed to the fact that the tractors can go from the elevated structure into the departments, haul out the trailers from trains and move these trains directly to their destination, eliminating both hand pushing and re-handling of goods. This greater flexibility of the tractor system is one of its main features in competition with the elevated railroad. In addition to effecting the direct saving on these tests, the tractors gave better and quicker service, and reduced the amount of overtime labour. The Armour Company has now 25 tractors and 1,500 trailers in service. These machines handle an average of 50 tons of freight each per 10-hour day. The hauls vary in length from 90 ft. to 1,100 ft., the average haul being about 400 ft. In practically all instances the hauling is over smooth surfaces of wood or concrete. What few grades are encountered are from 10 ft. to 25 ft. long and of from 2 per cent. to 10 per cent. slope. The 25 tractors have been placed in service a few at a time, care being exercised to place each unit where the volume of traffic, the condition of the docks and the length of the haul justified its adoption. In some cases the labour of three men was eliminated by one unit; in other cases one tractor displaced as many as seven men. The company figures that under these conditions the tractors will effect sufficient savings to pay for themselves in one year Perhaps the strongest point in favour of the storage-battery units is the fact that departmental foremen are in hearty sympathy with the change, largely because it brings them relief from labour shortages and from freight congestion.

ELECTRIC VEHICLES FOR POSTAL SERVICE.

Electric trucks are being used very successfully by the Postal Departments in a large number of American cities. St. Louis has had a fleet of electric trucks in its postal service for more than six years which have given splendid service even under the most severe weather conditions. These trucks are in service from 5.45 a.m. to 11.30 p.m., and average 30 miles each day. The postal service in Boston uses 15 electric trucks, which are operated on the "battery-service" plan, and make runs of 25 miles each day, resulting in substantial savings and greater efficiency in handling the mail.

The largest electric postal fleet is probably that of the New York Postal Transfer Service, which operates 47 "electrics." These trucks have been in service for three years, and are on duty for two ten-hour periods each day.

The dependable, simply-operated electric truck has been found almost indispensable in the postal service, which requires the speedy and safe negotiation of congested traffic.

It is interesting to note that several foreign countries have long appreciated the electric vehicle for postal service. A fleet of 30 electric trucks was installed in Vienna in 1913, and after a year's experimentation were pronounced to be particularly satisfactory for the transportation of the mails. This fleet has since been increased to 45 "electrics," and one truck has a record of 15 months' postal service in Austria, covering 500,000 kilometres with no interruptions for either battery troubles or repairs.

Recent reports from the Transvaal indicate that electric vehicles are used by the postal department of Johannesburg, and their economies in fuel and tyre costs have done much to popularise the "electric" in this African city. Electric vehicles, which are being used in considerable numbers for postal service in this country, have been successfully used in Berlin, Munich and Leipzig.

DOMESTIC ELECTRIC APPLIANCES IN TEXAS.

At Amarillo (Texas) the business manager of the City Light & Water Co. (Mr. W. B. McSpadden) reports that "there are no old-fashioned irons for sale in this city."

The fact became known recently when, in conversation with one of the ladies in charge of the local Red Cross work, Mr. Guy W. Faller (general manager of the company) was informed that the Red Cross ladies had been to every hardware store, furniture store, and every other place of [illegible] which should handle flat irons, and none of them had an old-fashioned iron in stock. In several instances the ladies were told that the demand for electric irons had grown so great that there was very little sale for the ordinary flat iron, so they did not carry a stock of them. Mr. Faller offered the ladies the use of as many electric irons as they needed, which they accepted with pleasure, and now the Red [illegible] boosters for the electric iron.

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CONTENTS.

Notes.

The Efficiency of the Air Pump.

Some little time ago the North East Coast Institution of Engineers and Shipbuilders took the important step of embarking on tests of certain engineering plant. A committee of expert engineers was appointed, the apparatus to be tested being offered by manufacturers. The first report of tests has now been issued and is concerned with methods of producing vacuum for steam plant. It is intended that the investigations undertaken by the Institution shall include air pumps of the reciprocating type and of the rotary and jet types. **The present report deals with tests made on pumps of the** reciprocating type only, the manufacturers in this case being **Messrs. Richardsons, Westgarth & Co., at whose works the** tests were carried out. The report is by Mr. Edwin L. Orde **(President of the North East Coast Institution of Engineers** and Shipbuilders), Mr. C. W. Cairns and Dr. John Morrow. It need scarcely be remarked that the production of a high vacuum is of the greatest importance in connection with steam **turbines. The point of chief technical interest in the report** is the fact that a remarkable influence on the withdrawal of air from a condenser is possessed by a steam jet or a series **of jets, when used in combination with air pumps. We** believe that the original idea of combining such a jet with an **air pump was due to Mr. James Atkinson, of London, who** in 1888 proposed its use in connection with the cooling of liquids under high vacuum. In 1902 it was developed by Sir Charles Parsons in his vacuum augmentor, and at later date it was considerably improved by Mr. D. B. Morison, of Hartlepool, in the "Kinetic" system.

The Importance of the Jet

The present tests demonstrate that no mechanical contrivance is so simple and so efficient as a steam jet for compressing a large volume of highly attenuated air under a small degree of compression, and it is already well known to engineers the reciprocating air pump is a very efficient means for discharging moderate volumes under a high degree of compression. It therefore follows that the correct solution of the problem of air discharge from a condenser is to withdraw a large volume of aerated vapour by means of one or more steam jets, compressing it through a range of compression at which the steam jet works with a very high economy, and then pass it on at such an absolute pressure that an air pump or other device can discharge it to the atmosphere, also with very high **economy. This combination also permits the reciprocating** air pump to be run at a much lower speed than would other**wise be possible for a given output. It appears to us that the policy adopted by the North East Coast Institution of Engineers and Shipbuilders in initiating such tests is most excellent, and that this example might well be followed by other engi**neering institutions. It is a policy which has been adopted by the Royal Automobile Club for many years, and which **undoubtedly resulted in marked improvement in the products made by automobile manufacturers. There is no reason why the older institutions should not have an equally beneficent effect upon engineering manufacturers by giving certificates of performance, without in any way lending themselves to undesirable advertisement.**

The Varied Applications of Light.

Mr. A. P. Trotter's Presidential Address before the **Illuminating Engineering Society on December 18th was specially interesting as showing the variety of applications of light with which the chemist, the physicist, the physiologist and the expert on illumination have to deal to-day. Mr.** Trotter's own interest in the subject dates back thirty **years ago. His Paper before the Institution of Civil Engineers** in 1892 is regarded as a classic and as one of the first clear **expositions of the distinction between the candle-power** of a source and the resultant useful effect in the form of **illumination. Since that date the developments of the study of illumination have spread out in directions which were hardly** contemplated 20 years ago, or even when the Illuminating Engineering Society was founded within the last decade. As **instances of special problems, Mr. Trotter mentions the work being done by two Committees of the Society on the illu**minating power of star shells, flares and parachute lights and on the brightness of luminous paint used for gun-sights, for **which special photometric appliances are needed. Of equal** interest were Mr. Trotter's experiences of the problem of street darkening. He states what many of us have long suspected, that it is impracticable to obliterate a large city by any special lighting restrictions, but that such measures can be practised with success in the case of small towns and **villages. From this point of view, independent control of** street lighting is highly desirable, for this would not only permit of easy warnings, but would also avoid the extreme darkening of streets that is often adopted. With street illuminations ranging down to less than one-thousandth of a foot-candle it is hardly surprising that street traffic has been attended by difficulties and that accidents appeared to be on the increase. On the other hand, the standard lighting devices adopted more recently are at least well screened from

the standpoint of avoiding glare. It may be, as Mr. Trotter suggests, that we shall benefit by our present experience, and that after the war we shall not return to the excessive brilliancy which was sometimes a disagreeable feature of street lighting in normal times.

Military Authorities and Engineers.

A correspondent in "Engineering" remarks on the disadvantages under which members of the engineering profession suffer in entering the Army. Officers of the Royal Medical Services and of the Army Veterinary Services are drawn from these respective professions, and receive a regular commission. On the other hand, although the "Staff for Royal Engineer Services" consists of specialist officers drawn from the engineering, architectural and surveying professions, the S.R.E.S. officer is only granted "honorary" rank, and as regards promotion his position is prejudiced thereby. He is the only officer from the professions so treated, and the subtle distinction between "honorary" and "substantive" rank will be appreciated by anyone conversant with Army sentiment. Certainly, if the facts are as stated, this is an unjustifiable anomaly, which the engineering profession should take up with the authorities.

Electrolytic Production of Solid Iodine.—L. Pisarshevski and S. Tjelin, in a recent Paper before the Russian Physical Chemistry Society, describe some preliminary attempts to separate iodine electrically from solutions containing iodides and other halogen compounds. A lead anode and a carbon cathode were employed, the former becoming coated with lead iodide deposited as a crystalline crust.

The Use of "Artificial Tides."—A recent issue of "Engineering" refers to some interesting experiments in water transport that have been made on the Ohio River. Artificial tides are produced by releasing water confined by dams constructed on the river between Pittsburg and Cincinnati. It is stated that on a recent trial trip 20,000 tons of coal were thus floated from Huntington, West Virginia, to Cincinnati by using such a "tide," and it is calculated that 250 trucks would have been required to transport this quantity of coal by rail. Artificial tides could be produced every 10 days or two weeks, and it is hoped that the device will be useful in relieving the pressure on the railways in the present emergency.

Screw Gauges.—A useful pamphlet of considerable length has been issued by the National Physical Laboratory on the "Production and Testing of Screw Gauges." The notes are the results of experience in testing gauges at the laboratory and have particular reference to some of the difficulties which occur in the manufacture and testing of gauges. Simple methods of measuring certain of the principal elements of the gauge are described. The pamphlet deals particularly with errors of screw pitch, the mechanical measurement of plug screws, details and methods of generating thread form, optical measurements of screw gauges and the measurement of ring screw gauges. Manufacturers who have experienced difficulties in measurement are invited to visit the Laboratory by appointment to discuss their particular problems with the members of the staff.

Keeping Records of Underground Distribution Systems.—A recent article in the "Electrical World," by M. [illegible], describes a system of [illegible] on the [illegible] system, [illegible] the keeping of a permanent record of underground [illegible]. The starting point in the system is the preparation of a standard distribution map showing the position of manholes, length and number of ducts, &c. These maps are kept on file in a loose-leaf binder, so that when a new [illegible] is [illegible] the [illegible] particulars can be conveniently inserted and related to previous data. There is also a neatly tabulated form summarising the house services, curb servicers and risers, whether used or unused. The rapid changes in a distribution system in a busy centre render it difficult to keep track of all developments, but this is attended to by a monthly review of the system, so that there should be available at any time an up-to-date ensemble of all the details.

Metallic Coatings on Glass.—In "Glashütte" a new application is described of the so-called Schoop process for applying metallic coatings to glass. According to this process the surface of the glass is heated until it just begins to soften and the surface is then sprayed with finely divided metallic powders. The metallic particles are thus driven into the surface of the glass and a very durable metallic coating ensues. It is stated that when the under surface of a glass flask is treated with copper or aluminium in this way the water can be raised to boiling point in three-quarters of the time that would otherwise be necessary, and, in addition, the vessel is much less liable to crack. One would imagine that this process would have useful applications for the treatment of glass reflectors for lighting purposes.

Journal of the British Science Guild.—The "Journal" of the British Science Guild for December contains some interesting notes on current events. Reference is made to the formation of the Society of Glass Technology, the scheme for the promotion of National Instruction in Technical Optics, and the manufacture of microscopes. A Report of the Committee on the Carnegie Trust and Scientific Research is given, in which Prof. Sadler is quoted in support of the contention that only a small portion of this fund is devoted to its primary object of stimulating scientific investigation. Other matters dealt with are the Problem of Child Mortality, the Registration of Schools and various educational matters. It is of interest to mention that Tasmania has now a State Committee on Science and Industry, and that a standing committee on Industrial Electricity has been appointed.

Tramway and Motor Omnibus Control.—Under the Defence of the Realm Act an Order has been made authorising the Board of Trade to make an order requiring the whole or any part of the rolling-stock, materials, and plant, including permanent way, of any such undertaking to be placed at their disposal or at the disposal of any person or body of persons named by them.

Where any such order has been made the Board or any such person or body of persons may take possession of such portions of the rolling-stock, materials, or plant of such undertaking as they may require, and may remove them and make use of them for the purposes of any other tramway or light railway.

In view of the appointment of a Board of Trade Committee to control tramways, some of the municipalities owning tramways are not only seeking direct representation on the Committee, but also urging that motor omnibuses should be similarly controlled.

The Commercial Use of Aircraft.—In a recent Paper before the Royal Society of Arts, Col. O'Gorman drew attention to the serious position in which the aircraft industry may find itself after the war, unless commercial applications for aeroplanes are studied beforehand. He pointed out that the wastage in war is far greater than it is likely to be in peace, and that there is a danger of a period after the conclusion of peace, during which there will be a sudden cessation of demand, and much of the present manufacturing facilities may be irremediably lost. The most hopeful immediate outlet for aircraft, he considered, is for post transport. Already aeroplanes are being used for this purpose in France and Italy, and the matter ought be considered *now*. There is no reason why routes should not be studied at present and future landing places provisionally selected under international agreement. A speed of 120 miles an hour is quite ordinary for aeroplanes and, in favourable circumstances a speed twice as great might be possible. By successive flights postal communications with the Colonies and Dominions might be greatly accelerated. It is interesting to note that in the opinion of the lecturer airships are not necessarily more economical for the transport of letters or goods than aeroplanes.

The Use of Soap Films in Solving Torsion Problems.—A paper by A. A. Griffiths and G. I. Taylor before the Institution of Mechanical Engineers on Dec. 14 describes a very ingenious method of applying soap-films to torsion-problems. The equations representing the torsion of an elastic bar of any uniform cross-section are of exactly the same form as those which represent the displacement of a soap-film, due to a slight pressure over its surface, the film being stretched over a hole in a flat plate, and the hole being of the same shape as the cross-section of the bar. This analogy can be applied to find the stresses and torsional stiffness of a twisted bar, and has the distinct advantage that there is no restriction on the shape of the section; whereas, except in certain cases, as for example, a circular section, the equations applicable to torsion stresses present great difficulties. The apparatus is designed to supply the following information:—(*a*) measurement of the inclination of the film to the plane of the plate at any point, for the determination of stresses; (*b*) determination of the contour lines of the film; (*c*) comparison of the displaced volumes of the test film and circular standard for finding the corresponding torque ratio. The factor (*a*) is determined by an ingenious optical method, the image of a lamp filament being viewed in the film in such a way that the reflected ray is coincident with the incident one, the normal to the film-surface being thus determined. In magnifying contour lines a needle point, moistened with soap solution and mounted in a glass plate, is moved about until contact with the film occurs, this being indicated by distortion of the image of the reflected point. The box containing the apparatus is so arranged that by shutting down the lid an impression of the top of the needle-holder is made on a white screen. Thus the contour lines can be traced out. The authors apply this method to the testing of a number of specimens of special section (triangular, elliptical, &c.) angle-irons, &c., which present considerable difficulties when treated by ordinary methods; in each case the section can conveniently be referred to a circular one, the behaviour of which is well established.

The Modulus of Elasticity of Electrolytic Copper.
In a Paper published by the Institution of Electrical Engineers, Mr. B. Welbourn discusses the modulus of elasticity of solid hard drawn copper conductors. It has been suggested that an all round value of 18,000,000 might be adopted in future. Some published values are as follows:—

—	Solid wire.	Stranded wires.
Verband Deutscher Elektrotechniker	18,000,000	—
Kapper (German)	19,000,000	11,400,000
Coombs (American)	16,000,000	12,000,000

In order to get actual values *under working conditions* tests were made by the author on an experimental span of about 150 ft., and special precautions were taken to prevent movement or bending of the terminal posts. The modulus was calculated by the formula due to Prof. Alfred Still, namely,

$$\frac{W_1}{d_1} - \frac{W}{d} = \frac{64 (d_1 - d) AM}{3 l^4} \text{ [illegible]}$$

where W_1 = weight per foot of unloaded strand (lb.)
W = weight per foot of loaded strand (lb.)
d_1 = dip in feet for W_1
d = dip in feet for W
M = modulus in lb. per sq. in.
A = cross-section of strand in sq. in.
l = length of span in feet.

From the above tests the following may be taken as suitable working figures:—

7-strand cable	20,000,000 lb. per sq. in.
19-strand cable	17,[illegible] lb. per sq. in.
37-strand cable	15,[illegible] lb. per sq. in.

As a result of this experimental work with long spans the earlier recommendation of 18,000,000 for *solid* wire, which was based on work on quite short lengths of wire, requires modification to 20,000,000 for working conditions, which is the value that should be adopted [illegible].

Obituary.

H. A. C. SAUNDERS.—We regret to record the death of Mr. Henry Alfred Charles Saunders, which took place in London on Dec. 8 last.

Mr. Saunders was born at Brighton in January, 1833, and educated at a proprietary school there. In March, 1854, he joined the late E. O. W. Whitehouse, and assisted in carrying out the preliminary experiments to determine the apparatus necessary to work an Atlantic cable. In December, 1856, he entered the service of the Atlantic Telegraph Co., and was employed in designing apparatus on the subterranean lines and cable between London and Dublin. During this time he was also associated with the late John Brett in carrying out the details of a Roman-type telegraph printing instrument; in 1857 he established the cable station at Valentia, and took part in the unsuccessful Atlantic expedition of that year, after which he was engaged in experiments on the cable coiled in tanks, to improve the working apparatus. In May, 1858, he was appointed mechanician and electrician at Newfoundland, when he established the station, and from December of that year to August, 1859, was in charge of the station. Mr. Saunders took part in 1859 and 1860 in the attempt to restore the broken cable, and in selecting a new landing place for a future cable—Heart's Content, the present landing place of the Anglo-American cables, being selected. He joined the electrical staff of Glass, Elliott & Co. in 1861, and assisted in laying various cables until January, 1864, when he went to Malta to take charge of the old Malta-Tripoli-Benghazi-Alexandria cable. In 1865 he was in joint charge of the electrical department on board the "Great Eastern" with the late Mr. De Sauty and the late Mr. Willoughby Smith, of the Atlantic cable expedition. In 1868 he accepted a joint appointment with the Anglo-Mediterranean Telegraph and Telegraph Construction and Maintenance Companies. He remained at Malta until 1870. He then entered the service of the Marseilles, Algiers & Malta and the British Indian Telegraph Companies, which, with the Anglo-Mediterranean and Falmouth, Gibraltar and Malta Companies, were amalgamated into the Eastern Telegraph Co. in 1872. He served in Egypt, Aden and India until 1875, when he was appointed electrician-in-chief in London, from which position he retired on Dec. 31, 1904. He was also electrician-in-chief of the Eastern Extension, Eastern and South African, Western, West African, African Direct and West Coast of America Telegraph Companies. On his retirement from the position of electrician-in-chief, Mr. Saunders was appointed consulting electrician to the Eastern and Associated Telegraph Companies.

Mr. Saunders assisted Lord Kelvin in bringing his cable instruments to perfection, and made various improvements in telegraph and testing apparatus, the best known of which is his fine wire and tube lightning guard, designed in 1869. He was also one of the earliest investigators of earth currents in cables, and was the first to discover the periodic variation in direction every six hours. This was observed in 1857 on the 300 mile length of Atlantic cable lost in that year.

The passing of Mr. Saunders severs yet another link with the earliest days of submarine telegraphy, and the news of his death will be received with regret in all parts of the cable world, especially in the Eastern hemisphere. Of quiet habits, simple and unostentatious, he will be greatly missed by a wide circle of friends.

Interment took place at Brompton Cemetery on Saturday, the 15th inst., and was attended by Messrs. A. R. Hardie, W. Hibberdine, F. E. Hesse and W. Judd, as representing the Eastern and Eastern Extension Telegraph Companies, and Mr. E. Steer Hodson, on behalf of the Western Telegraph Co. There were present also Mr. T. A. Bullock, Mr. S. Collett, Mr. B. Davis, Mr. G. R. Neilson and Capt. Pattison.

Personal.

Mr. C. J. Hunt, chief engineer to Messrs. Bruce Peebles & Co., Ltd., was married on the 22nd inst. to Miss Marion A. Lambert, of Edinburgh. As a souvenir of the occasion and also as a mark of appreciation, Mr. Hunt was presented with a handsome case of cutlery by the officials and staff.

Arrangements for the Week.

TUESDAY, Jan. 1st.

ROYAL INSTITUTION.

3 p.m. At Albemarle-street, Piccadilly, London, W. Christmas Lecture for Juveniles on "Our Useful Servants: Magnetism and Electricity." Lecture III.: "The Electric Current as a Heater and Chemist," by Prof. J. A. Fleming, D.Sc., F.R.S.

WEDNESDAY, Jan. 2nd.

ROYAL SOCIETY OF ARTS.

3 p.m. At John-street, Adelphi, London, W.C. Juvenile Lecture on "Animal Camouflage," by Dr. P. Chalmers Mitchell, F.R.S.

AERONAUTICAL SOCIETY OF GREAT BRITAIN.

3 p.m. At the [illegible], London, W. Juvenile lecture on "The Aeroplane," by Dr. A. P. Thurston.

THURSDAY, Jan. 3rd.

ROYAL INSTITUTION.

3 p.m. At Albemarle-street, Piccadilly, London, W. Christmas Lecture for Juveniles on "Our Useful Servants: Magnetism and Electricity." Lecture IV.: "[illegible]," by Prof. J. A. Fleming, D.Sc., F.R.S.

Notes on the Electric Equipment of Machinery for the Handling of Materials.

Summary.—In this article a number of points are discussed in regard to what may be termed the details of electrical equipment. These include motors, speed regulation, electric braking, controllers, resistors and switchgear.

(*Continued from p. 467.*)

CONTROLLERS.

Drum Type Controllers.—For normal service and for motors of small and medium output, the drum type controller, as manufactured by specialist firms of repute, leaves little to be desired either from a mechanical or an electrical point of view. The connections are easily understood; the parts likely to require adjustment are few in number; relatively few spare parts are needed, and the first cost is low.

It is well to remember that many controllers can, without alteration, be used for any and every type of continuous-current motor. Thus, in Fig. 7 is given the development of a symmetrical controller having five notches on each side, and in the same diagram it is shown how this controller may be used for operating a series, shunt, compound or commutating-pole motor.

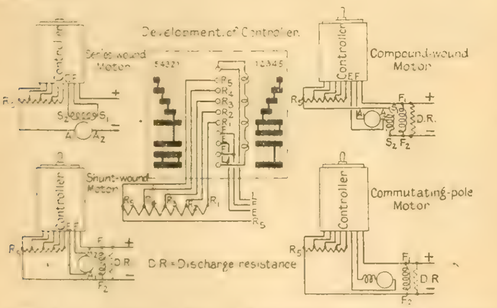


FIG. 7.—DEVELOPMENT OF SIMPLE REVERSING CONTROLLER SHOWING CONNECTIONS FOR DIFFERENT TYPES OF MOTOR.

The development of a modern lifting motor controller arranged for dynamic braking on the lowering side is given in Fig. 8 (*a*), and the circuits corresponding to the several notches on each side are depicted in Fig. 8 (*b*).

A note on the grading of resistors is given below, but it may be of interest here to mention that the resistor for this controller is proportioned as follows:

Grading of Resistor for the Controller shown in Fig. 8.

Resistance step R_1 to R_2 20 per cent.*
R_2 to R_3 35 "
R_3 to R_4 15 "
R_4 to R_5 25 "
R_5 to R_6 18 "
R_6 to R_7 13 "
A to B 2½ to 10 per cent.

If the motor is found to lower at too great a rate the speed can be reduced by decreasing the resistance steps R_1R_2 and R_7R_8. Should the brake fail to release in the lowering position this can be corrected by increasing the resistance step AB. It may be mentioned that the brake should release with a current not greater than 10 per cent. of the rated current of the motor. When a shunt-wound brake releasing electro-magnet is used it must be connected between L_1 and finger O in the controller.

Liquid Controllers.—These perform all the functions necessary for starting, stopping, reversing and speed regulation of induction motors. They are largely used for mine hoists and similar equipment, but nowadays there seems to be a tendency to use metal resistances and contactor-type controllers. Liquid controllers are now seldom used for motors of small output.

* 100 per cent. = rated full-load current.

Controllers of this type are characterised by simplicity of construction; large thermal capacity and, under certain conditions, smooth variation of resistance. The gear consists essentially of three parts:—

(*a*) Two switches for making the necessary connections for either direction of rotation between the three-phase stator winding and the supply.

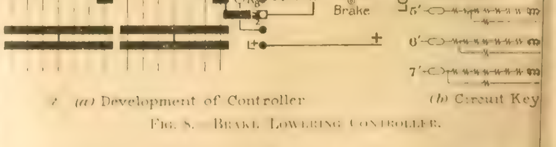
(*b*) A liquid resistance for the three phases of the rotor.

(*c*) Operating gear.

The movement of the operating gear from the "off" position in either direction first closes one or other of the switches connecting the stator to the supply, and further movement reduces the liquid resistances in the rotor circuit until the "full-on" position is reached, when the motor runs at maximum speed. Mechanical interlocks make it impossible for any of the parts to operate in any but the correct sequence.

Mr. R. F. Baerlocher has devised the ingenious arrangement shown in Fig. 9 for securing automatic acceleration with a liquid controller having moving electrodes. Along with a well-thought-out system of securing circulation of the electrolyte it is incorporated in the liquid controllers manufactured by Messrs. West & Co.

Circulation is induced by the heated electrolyte rising from the space between the electrodes through and around the moving electrodes. This heated column of electrolyte rises till it reaches the top of the baffle plates, when it is drawn downwards, as shown by the arrows in Fig. 9, by the downward flowing cooled electrolyte. The only path for the cooled electrolyte is down the channels communicating with the passages in the stationary electrodes and up again through the space between the electrodes. This circulation, being maintained even in the lowest position of the electrodes, prevents the accumulation of hot electrolyte, steam or gas, and ensures a smooth control over the speed.



(*a*) Development of Controller (*b*) Circuit Key

FIG. 8.—BRAKE LOWERING CONTROLLER.

A schematic diagram of a Westinghouse liquid controller for wound-rotor induction motors of large output is given in Fig. 10. When the operating lever is moved from the "off" position the magnet switches in the stator circuit are operated by the master switch and the weir is raised; the electrolyte (which is circulated continuously by the pump) rises, thus decreasing the resistance in the rotor circuit and speeding up the motor. A regulating valve in the pump discharge pipe prevents the liquid from rising in the electrode tank at a greater rate than that for which the valve is adjusted. In this manner although the control lever be moved directly to the "full-on" position the liquid will rise at the rate determined

by the valve setting. The weir, however, is of such a size that the electrolyte will flow freely to the lower compartment.

As a rule, liquid controllers are provided with cooling arrangements which limit the temperature rise of the electrolyte to about 30°C or 50°C. In the controllers manufactured by Messrs. Brown Boveri & Co., energy is dissipated by boiling the electrolyte under atmospheric pressure. The steam generated is either discharged into the open air and the level maintained by a continuous supply of fresh electrolyte, or it is condensed and retained in the controller. In the latter case, cooling water for a condenser is required, and the losses are made good by the addition of a small amount of electrolyte.

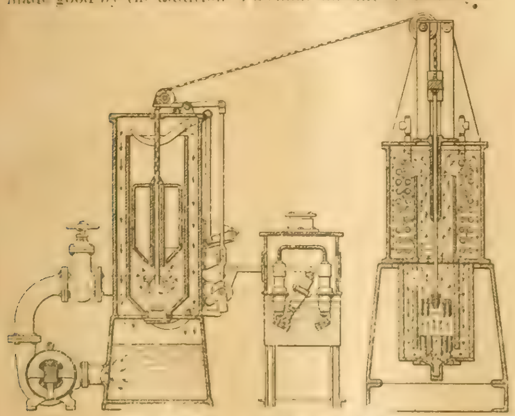


FIG. 9. WEST LIQUID CONTROLLER.

This method results in a reduction in the size of the cooling apparatus, even in the case of continuous regulation, because the transmission of heat from steam to the cooling water is more efficient than that from hot electrolyte to water.

Contactor-type Controllers.—When the motors are of large size, and practically in all cases where the service is very severe, controllers of the contactor type are more dependable, are easier to operate, and lend themselves more readily to automatic or semi-automatic operation than controllers of the drum type. In the early days of contactor type control there was a tendency to overload the gear with automatic devices, and neither the connections nor the adjustments were properly

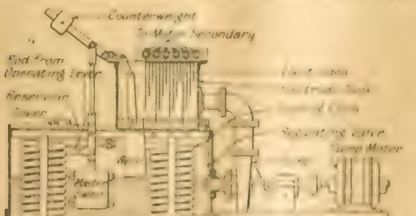


FIG. 10.—WESTINGHOUSE LIQUID CONTROLLER.

understood by the works electrician. The progress that has been made in recent years in the development of industrial control gear is due in large measure to the elimination of appliances of a more or less delicate character, and to the simplification of the connections.

In its simplest form a contactor controller consists of a number of electrically operated switches called contactors and a small master controller for admitting current to the operating coils of these switches. As we shall presently show, such control systems admit of wide variation. They are suitable for direct- or alternating-current motors, and can readily be arranged for reversing, automatic acceleration and electric braking.

Confining our attention to direct-current equipments, current-limit acceleration may be obtained in two ways, one by using current-limit relays which control the closing of the shunt-wound accelerating contactors; and in the other, series-wound contactors are used.

An interesting application of shunt-wound current-limit contactor control is depicted in Fig. 11 (*a*). This contactor is arranged for regulating the speed and reversing a series-wound motor. The connections of many controllers are difficult to trace, and those not fully conversant with the subject will find it advantageous to prepare from the wiring diagram of the complete controller, a further diagram, Fig. 11 (*b*), of the main connections as well as a table, Fig. 11 (*c*), showing the contactors in action for each position of the master-controller. From these can be laid down a main circuit key, Fig. 11 (*d*), for each of the several notches. These diagrams serve to make the action self explanatory.

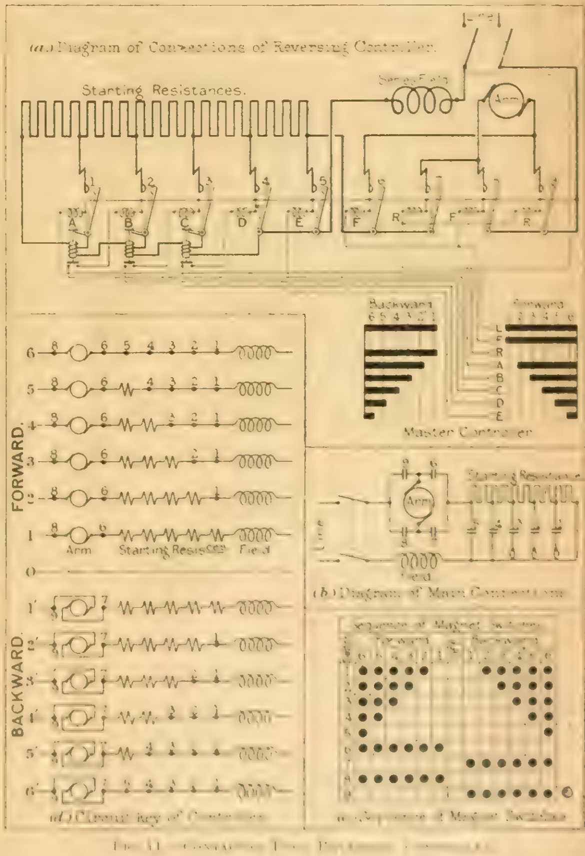


FIG. 11.—[illegible] CONTROLLER.

Direct-current contactor controllers for crane and similar service may be broadly classified as follows:

(a) Reversing, [illegible], automatic acceleration, [illegible] speed control (Fig. 12).

(b) As above, but with speed control.

(c) Reversing, automatic acceleration, [illegible] dynamic braking in "off" position (Fig. 13).

(d) As (c), but with speed control.

(e) Reversing, automatic acceleration, with speed control, electric braking [illegible] (Fig. 13).

Referring to Fig. 12, when the [illegible] "off" position of the master controller [illegible]. Throwing the switch to the "forward" position [illegible]

1. 3 and 7, and the switches close, thus starting the motor. The main current now energises the operating coil $O.C'_6$ of switch 6. After the starting current has fallen to a predetermined value the series lock-out switch closes, short-circuiting a portion of the starting resistance, and at the same time cutting into the circuit the operating coil of switch 5. When the current has again fallen to the proper value, switch 5 closes, short circuiting all of the starting resistance as well as the operating coil $O.C_6$. The motor is now direct on the line.

In order to stop the motor, the master-switch is simply thrown to the reverse position. This operation de-energises the coils of all the switches which were "in," thus causing these switches to drop out. At the same time the coils of

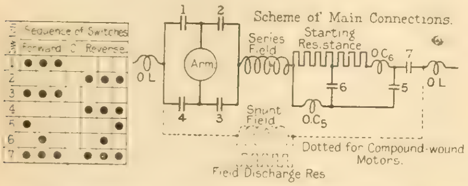


FIG. 12.—CONTROLLER FOR QUICK REVERSING WITHOUT SPEED CONTROL.

switches 2, 4 and 7 are energised and the switches close, stopping the motor by "plugging." Leaving the master-switch in the reverse position will cause the motor to start in the reverse direction, the switches operating automatically as described above for the forward position.

Controllers under group (c) are used where accurate control of the motor is desired and where speed control is not necessary. They are similar to those just described, with the addition of electric braking obtained by means of back-contact magnet-switches. A typical diagram of connections of a controller for a compound-wound motor is given in Fig. 13.

When the controller is moved to the forward running position, switches 1, 3 and 5 close and switch 1A opens. The circuit of the motor is now established through all the starting resistance and $O.C_6$, and, as the motor accelerates, the current drops to a pre-determined value at which switch 6 closes, cutting out resistance step R_1R_2 and energising $O.C_7$. When the current again drops to a pre-determined value, switch 7 closes, cutting out the last step of resistance R_2R_3 as well as $O.C_6$. This opens switch 6 and connects the motor directly across the line.

If the master-switch be moved to the "off" position these

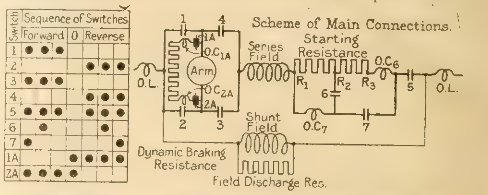


FIG. 13.—CONTROLLER ARRANGED FOR ELECTRIC BRAKING IN "OFF" POSITION.

switches open, and switch 1A closes. This establishes an electric braking circuit and brings the armature quickly to rest. When the master-switch is moved from the "forward" position to the "reverse" position the motor will not reverse until the braking period is over, as coils $O.C_1$ and $O.C_2$ seal the back-contacts and prevent the directional switches from closing. Thus the motor cannot be plugged in any case.

(*To be continued.*)

Mr. A. P. Trotter's Presidential Address to the Illuminating Engineering Society.

At the meeting of the Illuminating Engineering Society on Dec. 18 a record of events during the Vacation was presented by the Hon. Secretary (Mr. L. Gaster), who referred briefly to the Joint Committee on Illuminating Engineering now acting under the Department of Scientific and Industrial Research and to the work of other committees carrying out special investigations for the Ministry of Munitions.

The Illuminating Engineering Society was also represented on the London Safety First Council, and had been invited to co-operate with the Cinema Commission of Enquiry in regard to the lighting of cinema theatres. A report, in which reference was made to the necessity for adequate illumination, was recently published by this Committee.

Reference was also made to the assistance rendered to the United States Government through special committees by the American Illuminating Engineering Society and to the contemplated formation of an Illuminating Engineering Society in Japan.

Mr. A. P. Trotter then gave his address, of which the following is an abstract:—

The name of the Society which has honoured me by electing me as its President was wisely chosen seven years ago. It is not the Society of Illuminating Engineers. At that time it was doubtful whether anybody was entitled to be called an illuminating engineer. To-day, an astonishing number of considerations must be studied by one who undertakes to give competent and impartial advice on illumination.

The output of scientific work flows through four main channels, namely, the journals of scientific societies, the publication of books, the technical Press, and the work done in the private laboratories of manufacturers, which, if divulged at all, is published only through the Patent Office.

The object of most scientific societies is the publication of the original work of its members and provision for discussion. In our Society we have often arranged for discussions without exacting heavy work from the authors of Papers. A very few terse statements are sufficient to provoke a good debate if the subject be well chosen.

The multiplication of scientific societies is sometimes regretted, especially by older men. But excellent scientific work has been done, work that could not in any other way have been performed, by such comparatively small bodies as the Faraday, the Röntgen and the Wireless Societies.

The peculiar value of a Society such as ours is that the membership, and therefore the audiences, and hence the discussions, are representative of interests which differ widely. Yet the Society has been held together by the bond of science, and the fact that it has been so held, proves, if proof were needed, that it is essentially a scientific society.

In illumination it is always necessary to take into account the impressions of the eye. A photometer may make a definite statement, but we must consider the context. For this reason our Society seeks the assistance of that branch of the medical profession which cares for our eyes. We also look to physical science in connection with new sources of light, and to applied mathematics for methods of exact or of ready measurement. We are dependent on that difficult branch of chemistry, the art of glass-making, and we must be able clearly to explain to manufacturers what we want, and to see that we get it. Few, if any, scientific societies spread their activities over so wide a range and are in touch with so many different arts and industries.

As knowledge advances new terms become necessary to express new concepts. In our branch of science new terms do not grow by accretion as in chemistry or zoology where each newly discovered substance or animal must receive a name. They multiply by fission, by the discovery that an idea, hitherto considered simple, is complex. Except in that branch of our work which deals with illuminants, our precepts remain much the same as those of Bouguer and Lambert in the middle of the 18th century.

The nomenclature of our subject has three aspects. One takes in the terms in ordinary use and includes some recognised but more rarely used expressions of a mathematical character. Another presents new terms or new relative orders or arrangements of terms. The third is the international outlook. It is fortunate that the vocabulary of illuminating engineering is not a large one. We

sometimes find it necessary to coin new terms, borrowing if possible a Latin word, such as Lumen, Albedo, or Lux. Lastly there is the correct translation of terms used in other countries, and the difficult question of logical sequence. There is a proposal to use the lumen as the fundamental unit and to make the candle and candle-power secondary or derived quantities. Our Society has given some attention to the controversy which has arisen, and while we all admit that the lumen offers certain advantages in simplifying calculations, the matter requires further study.

We have had a great controversy also about street lighting, and in their efforts to carry their views, members have done much useful work.

Controversies, however, have a habit of settling themselves. Minorities who bide their time instead of beating their heads against a wall, find that the views which were at one time so strongly opposed become adopted and blended with those of their former antagonists.

By reason of the wide range of our interests, we are in touch with several different scientific bodies from which we should derive help by offering them as much assistance as we can. Their function is to turn the mills of organisation, ours to supply a share of grist.

This is a body affiliated to the International Commission on Illumination. It was constituted in 1914 by the co-operation of our Society with the Institution of Electrical Engineers, the Institution of Gas Engineers, and of the National Physical Laboratory, to carry on and to develop the work which had been begun by the original International Photometric Commission.

The Committee have given preliminary consideration to a uniform international method of rating and marking all sources of light, and to the nomenclature of photometric terms. When their work is resumed the Committee will doubtless co-operate with any other bodies, such as the Engineering Standards Committee, who are dealing with these subjects.

The unit of luminous intensity has been agreed upon by France, Great Britain and by the United States, and will probably be adopted by all civilised nations, and we call it the International Standard Candle. This is a rather unfortunate expression, for it makes a confusion between a unit and a standard. We are all agreed upon the unit, which is derived from the old Parliamentary candle, and still bears the name, but the desideratum now is some actual apparatus which can be constructed to a definite specification, and, subject to working corrections, can be relied upon to emit unit luminous intensity.

It was briefly stated in our last annual report that a deputation of our members approached the Department in March, and submitted descriptions of the work of our Society and the directions in which it appeared that the operations of the Department might be extended to illuminating engineering. The result was that a Joint Committee of the Standing Committee on Engineering and on Glass and Optical Instruments, on Illuminating Engineering was constituted.

The Committee have inquired about goods which were imported from Germany or Austria before the war, and which were not made at all in this country. The valuable work of Sir Herbert Jackson on the manufacture of kinds of glass which have not hitherto been made in this country is placed at the disposal of the Committee, and when their recommendations are made as to the directions in which new branches of manufacture should be started, the Committee will be in a position to provide makers with samples, formulæ, and directions for making the goods.

Another branch of work in which the Committee may be able to render service is the specification of quality and performance. Twenty or thirty years ago it was supposed that a sheet of ground glass or ordinary opal glass cut off from 40 to 60 per cent. of light because this appeared to be the case when such a sheet was interposed between a lamp and a photometer. The public is entirely in the hands of the dealer in these matters. At present it is nobody's business to look into these questions, and it appears to be one in which the Committee might act with advantage to the general public as well as to the lighting industry.

It is not possible at the present time to discuss freely the desirability of darkening the streets of towns during war time as a protection against air raids, or the degree or mode of darkening if this is considered advisable.

That considerable section of our Society which is interested in street lighting viewed with dismay in the early part of last year not only the suppression of all the work which had been [illegible] studied in connection with the Standard Tables for Street Lighting Specification, but also the alarming increase of accidents, especially in the streets of London.

The original orders for darkening of London were [illegible] upon the Admiralty, and there was no time to go into new and difficult questions, and of course there was no opportunity to give [illegible]. The defence was afterwards transferred to the General Headquarters of the Home Forces at the Horse Guards, and the need for some modification soon became apparent. In November, 1916, I was sent for, and was asked to consider certain points which were put before me, and, with an officer of the London District, I inspected various parts of London in which the lamps had been obscured in various ways. In one street I measured an illumination considerably less than one-ten thousandth of a foot-candle. I was asked to consider how much light could be allowed without revealing the topography of the district. In order to study this question more carefully, I was invited to make an aerial reconnaissance from a balloon at night. At that date, the streets were easily traceable by the patches of light below the screened lamps. It is sufficient to say that the authorities are of opinion that it is impossible to hide such a city as London by reducing the street lighting. On the other hand, this does not apply to small towns, which can be obliterated by extinguishing all street lamps and by careful shuttering and screening of the windows.

In the warfare of the future we must expect surprise attacks by large air squadrons. It will be necessary for engineers to consider the best means for control of street lighting, and, indeed, of all outdoor lighting, from the source, and provision for immediate extinction, when called upon by the military authorities to take this step. An independent street lighting system affords an excellent method of giving warning of an air-raid at night.

It is doubtful whether we shall ever return to the blatant glaring over-lighting of the years preceding the war; and when the lights are "turned up" again, the public will demand quality when they are offered quantity.

Silvanus Thompson, in his Inaugural Presidential Address on the founding of our Society, referred to the fact that the secret of the firefly is still hidden from us. The quantity of energy which appears as useful light is about 2 per cent. of the energy radiated from an electric glowlamp; in the firefly it is about 96 or 97 per cent. In other words, if we could produce a highly efficient lamp, the light-generating output of a dynamo would be 50 times greater than now, and 45 lb. of coal would do what a ton does to-day. The cost of lighting will not be reduced in anything like the same proportion. The cost of fuel is about one-tenth of the selling price of the light. The ordinary London householder pays 3d. to 6d. for his domestic lighting, which entailed a consumption of about 0·44d. of coal at pre-war prices.

While so many engineers and scientific men have been eager to do something for the war, and so few have succeeded in finding any appreciation of their services, our Society must be content to have been allowed to carry out more than one investigation for which it was well fitted. Silvanus Thompson said that fireworks, as well as fireflies, were of some interest to the illuminating engineer. The starshell, flares and parachute lights which play so important a part in the war are but fireworks.

It was recognised that photometric tests would be useful. Our Society offered to find men who would suggest methods and give them time necessary to carry out the work. A committee was accordingly formed; it conferred with the experts, who cordially placed their data and requirements before the members; a special photometer was at once discussed, designed, and made. The observations on a large number of samples, both of service patterns and of experimental kinds, were made by the committee during night meetings, and were reduced to candle-power-seconds per gram of composition, and it is hoped that the results have been useful.

Night operations of war have directed attention to this subject, and the old method of [illegible] by light has given place to continuous stimulation by alpha rays of radium compounds. Dials of watches and compasses are well known, [illegible] research.

[illegible]

[illegible]

Interim Report of the Coal Conservation Sub-Committee of the Reconstruction Committee.

This interim report, which was drawn up on April 16, 1917, has now been published. It is presented to Lord Haldane (chairman), and is signed by Messrs. C. H. Merz (vice-chairman), W. A. Bone, Guy Calthrop, J. Kemp, Sir R. A. S. Redmayne, and Mr. C. P. Sparks. The matter is under further consideration by the Board of Trade Power Committee.

Electric Power Supply in Great Britain.

It is pointed out that the economical use of coal for industrial purposes in the United Kingdom is of special importance in view of the influence of coal on the cost of production. The average coal consumption per horse-power hour throughout the country has been halved during the last 25 years. In spite of this the total amount used has increased. A consideration of the probable future development of British industries shows that it is not so much by reducing our total coal consumption as by increasing our individual output for a given coal consumption that progress will be made. Unless this result is attained we shall be faced with the necessity of doubling our coal output or reducing our coal exports to nothing. But the present coal consumption would, if used economically, produce at least three times the present amount of power.

In considering the future it may, we think, be assumed not only that the output of industry will continue to increase, but also, that the use of mechanical power will even more rapidly, continue to replace, or at least to supplement, human labour. The only way to increase prosperity is to increase the net output per head of the workers employed. It is possible to increase the output per head by harder work on the part of each individual, but there is far greater promise in increasing his output by giving him more machinery to multiply the effectiveness of his efforts. In the United States the amount of power used per worker is 56 per cent. more than in the United Kingdom. On the other hand, not only are the standard rates of wages higher in the U.S.A., but living conditions are better. The best cure for low wages is more motive power.

One question which has been settled conclusively during the past 15 years is that the most economical means of applying power to industry is the electric motor. Thus, the problem is not so much how to apply the power to the tool or process, as the case may be, but how best to generate the electric power.

Now, it is certain that arrangements ought to be made in the near future for the manufacture in the United Kingdom of many products necessary for the development of the industrial community, which are not now made here and which require large amounts of electric power at very low cost. If an attempt is made to erect electric generating stations for the sole purpose of supplying electro-chemical plants for new processes and also for the manufacture of products at present imported, not only shall we not get the cheapest power, but we shall have to use a great deal more coal. [illegible]

[illegible] great economy of capital, labour and coal.

[illegible] 12 months between 600 and 700 million units. While the present position is most unsatisfactory, the future expansion of these undertakings gives rise to still greater apprehension. Important extensions on new sites are already projected, the additional plant proposed aggregating some 300,000 kw. to 400,000 kw. In the case of Birmingham, the new site chosen is within the City boundary, and the condensing facilities are limited to cooling towers, and owing to shortage of water supply raw sewage effluent will have to be used for "make up" purposes. In the case of Sheffield, the new site, which is the subject of a Parliamentary inquiry, adjoins the city boundary, and cooling towers for dealing with a 50,000 kw. demand will have to be used during long periods of the year.

The use of electric power, generated in central stations, for all classes of work would show a considerable increase with the decreasing cost of electricity so generated. If power is to be supplied throughout the country at the lowest possible price, the following conditions must be secured :-

1. The power users in each industrial district must be supplied from one common inter-connected electrical power system.

2. Large generating machines, not less than 20,000 H.P., must be used, and they must be erected in the best possible positions for economical production. In the more important industrial districts generating machines of 50,000 H.P. might be advantageously used.

3. Power available from surplus gas or waste heat should be turned into electrical energy on the spot in local plants which would feed into the main distribution system. N.B.—As regards waste coal, this could, where transport was the ruling consideration, also be used on the spot.

On account of the compact nature of the country such a system is commercially practicable and advantageous here to a greater extent than it would be in other countries, but just as trade between different parts of the country would be impossible, or practically impossible, without railways, so trade in power—that is the supply of power where most required from the source where it can be most economically generated—is impossible without trunk mains. Such trunk mains or electrical "roads" must be standardised.

There are important additional advantages to be secured from the erection of plants on roomy and efficient sites rather than on crowded and inefficient sites, apart altogether from those resulting from the increase in the size of the plant :

1. Centralisation of production materially facilitates supervision and ensures the better operation of any given plant as regards improvement in general coal economy.

2. The health of the great industrial centres and the congestion of the railway lines in their neighbourhood would be radically improved by arranging for the conversion of coal into motive power to be carried out away from the densely populated centres.

3. By locating either the main or supplementary plants at or near the collieries much coal that is now wasted or left in the pits could be profitably utilised, and the coal which would otherwise be burned to transport the coal used would also be saved.

4. By-products obtainable from the coal before it is consumed in the boiler furnace, or producer, could be extracted in any case where it was proved to be economical to do so. These by-products may be of as great value to the country as the fuel residuum, for nitrogenous fertilisers, crude oils, oils for marine propulsion, and motor spirit for road traction, can all be largely extracted from coal.

At the present time the supply of electricity in Great Britain is divided between some 600 company and municipal undertakings. The average generating plant capacity of those undertakings which have power stations is 5,000 H.P., or about one-fourth of the capacity of one single generating machine of economical size, and about one-thirtieth of the size of what may be considered as an economical "power station unit."

It is not suggested that a scheme of power distribution for the whole country can be treated as an ordinary engineering project and commenced "de novo," but it is urged that the time has now arrived for the matter to be considered comprehensively and for the reorganisation of the existing indiscriminate power supply systems to be undertaken on correct lines. To utilise plant existing at the present time to the best advantage is by no means an easy problem. The main transmission system must be alternating current three-phase at high voltage—no engineer would dispute it—but a more difficult question is that of frequency; in Great Britain no less than 10 frequencies are employed to-day. The chief difficulties are, however, not technical, but what may be called political.

In order to illustrate the inefficiency of the present system of dividing up the supply of electricity into a number of small undertakings, in most cases the property of a municipal authority and confined to a municipal area, a list of the average prices received for current by a number of representative municipal undertakings in the Lancashire industrial district is given and compared with the average price paid by consumers on the North-East Coast. The latter is less than ½d., whereas the former is much higher.

While it might be feasible for local concerns, whether municipal or company, to retain, as separate bodies, the ownership of mains and the business of supplying lighting and small power consumers, the generation and main transmission and distribution of electrical energy and the business of supplying power to manufacturers, railways and other large users, must, in each district, be in the hands of one organisation.

The proposal to link up adjacent power stations is a step in the direction of greater economy and should be encouraged, provided it is appreciated that it is only a step. As a permanent solution it is not effective, for, first, it is impossible to run a large number of linked up stations at the highest economy unless they are under the same ownership and control, and, secondly—and more important—where such stations are under separate control a linking-up scheme, pure and simple, tends rather to perpetuate the uneconomical station than the reverse. To regard a scheme of linking up between existing concerns as a permanent solution is hopeless.

It has been frequently proposed as an alternative to mere linking up that bodies should be created which would deal solely with bulk supply, existing authorities being compelled to take all further electrical energy beyond what they can generate in their present stations from the new bulk supply system, and being allowed to run their existing stations as far as they desire to do so for a period of years. The disadvantages are:

1. That it would take much longer to make a change over to economical generation on account of the tendency of the existing bodies to wish to keep their own plants.

2. That the delay in the transfer of the load would prevent the greatest economies being effected on account of the less load the new stations would have to deal with.

3. That when the transfer was complete, as in time it would be, because of the lower cost of the new system of generation, the existing bodies would be left with indifferent obsolete plants.

4. If the existing stations were owned or operated by different bodies they would not be of much use for stand-by and peak load purposes, as they might otherwise be.

On the other hand, wherever there is unity of ownership and control not only are all the advantages of linking up secured but the erection on correct lines of all further generating plant required is assured. If single ownership and control are once secured for a district there is no political or other reason why all plant should not be of the most economical type and size, and installed on the best possible sites; the individualistic system of a separate station for each municipal area will be abandoned, and centralisation of production by means of the largest possible prime movers will be secured.

If such a system were inaugurated it may be confidently stated that on the basis of the extent to which power is used at present a saving of 55 million tons of coal per annum [illegible] be expected. Taking the value of this coal for export purposes at 10s. per ton the national annual advantage of the change, available for interest on capital, is, say, £27,500,000 in coal alone. This takes no account of incidental advantages, which would be not less than £100,000,000 per annum.

In order to secure, even on existing lines of development, the more correct extension of electricity undertakings as the demand grows, it has been proposed to appoint electricity commissioners. While this step is certainly desirable, and nothing should be done in any way to delay its being taken, it is considered that the proposal does not go far enough and would not result sufficiently rapidly in the establishment of a comprehensive electricity supply system throughout the country. What is required is not only the appointment of commissioners, but the instruction to them to arrange in each district for the establishment of one electricity body owning and operating the electricity supply system [illegible], except possibly for dealing with lighting and small power consumers, to take over all existing stations and mains [illegible] power supply system for the district, and at once making arrangements for the generation of power on a large scale, preferably from super-stations erected also for dealing with the [illegible] processes already referred to.

This raises the question as to whether it is necessary for such a body to take over the electricity supply business [illegible], the business should be dealt with by the State, [illegible], by private enterprise, or by a combination of [illegible].

An analysis of the existing situation in the industrial areas of the country indicates that there are very different conditions in the different areas as regards municipal ownership. It would, therefore, appear that one solution is not necessarily applicable to every case.

What is essential is that the national policy should be changed. The aim in future must be to concentrate under one authority for each industrial district, firstly, the main distribution system—that is to say, what may be called the main trunk electric roads—and, secondly, the responsibility for the location of the generating machinery in the most economical positions.

Your sub-committee have carefully reviewed the above considerations, and in framing their recommendations they have had before them that:—

(a) This question has been prominently before Parliament for different districts on numerous occasions and no solution has been arrived at.

(b) Consequently, with one or two exceptions, there are practically no modern electric power generating plants in the country.

Existing generating plants are uneconomical and ought to be scrapped, but this cannot be done until more modern plants are made available. If, however, such plants were established and running, and it were, therefore, possible to recommend existing authorities to connect up to these big plants, and they were sure of being able to get power at short notice if they did so connect up, the position would solve itself on purely economic lines.

RECOMMENDATIONS

1. It is essential that the present inefficient system of over 600 districts should be superseded by a comprehensive system in which Great Britain is divided into some 16 districts, in each of which there should be one authority dealing with all the generation and *main* distribution.

2. Centres, or sites, suitable for electric generating purposes should at once be chosen on important waterways as the future main centres of supply for each of the districts into which the country is to be divided.

3. The sites so chosen should be as large as possible, having in view the land available in suitable localities, and should have ample water and transport facilities. Land is required not only for the power stations themselves—which for the sake of security and safety would have to be suitably sub-divided, that is, they would not be contained all in one building—but for the processes involved in the extraction of by-products from the coal before it is used for the production of power, where such extraction is found to be justified. It is also required for the development of electro-chemical processes, which may be most conveniently carried on in close proximity to the power plant. This condition entails the sites being chosen outside, not inside, towns.

4. Plans should be prepared for the construction immediately after the war on these sites of the first instalment of large super-power plants capable, first, of supplying, through a comprehensive electric power distribution system which must be also arranged for, the existing demands of the community, and, secondly, of supplying electrical energy at the lowest possible price for new processes and manufactures.

5. Such plants would be designed so that, as methods are perfected for extracting by-products from the fuel, before using it for the purpose of the production of electric power, the by-product plant can be combined with the power plant. Each site should be laid out with this view, and with a view to the unrestricted extensions of the plant as required.

6. Power available from surplus gas or waste heat should be turned into electrical energy on the spot [illegible] which would feed into the main distribution system. As regards waste coal—*i.e.*, coal which it does not at present pay to bring to the surface—this could, where transport was [illegible], be used on the spot.

7. [illegible]

8. [illegible] They should have power—*inter alia*—:

(a) [illegible] public supply.

(b) [illegible]

(c) [illegible] transmission and distribution systems.

(d) [illegible]

9. [illegible] State assistance in [illegible]

[illegible] N.E. Coast [illegible] Electric Power Companies.

The Electrician.

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Coal Conservation and Electric Power Supply.

On another page we publish in abstract the report on electric power supply in Great Britain by the Coal Conservation Sub-committee of the Reconstruction Committee. It may be said that the waste of coal is the text upon which the report is built. In this country coal has been so cheap, this cheapness being one of our national assets, that we have not troubled so much as we might have in other circumstances to reduce waste to a minimum. It is now time for a change in policy. As is well known, much might be done to economise coal if the isolated steam plants in the factories of this country were replaced by the electric motor, and if the less economical power stations could be shut down and their requirements supplied from large up-to-date stations.

There is another aspect of the matter, and that is the extent of product per annum per employee in factories. It is pointed out, and we think correctly, that if wages are raised merely by increasing the selling price of goods in the home markets there is no real advance, and to increase the selling price of goods in neutral or open markets is hardly possible in view of international competition. Nevertheless, it is essential that the wealth of the country should be increased after the war. It follows that the only way to increase prosperity is to increase the net output per head of the workers employed. Generally speaking, this output can be increased to some extent by harder work on the part of each individual, but there is greater promise of the necessary increased output by giving the individual more machinery, so as to multiply the effectiveness of his efforts. In other words, the output per individual depends on the horse-power utilised per individual employed. In the United States this is 56 per cent. higher than in the United Kingdom. It is of great importance, therefore, to cheapen electric power and to render it more generally available.

There are two means of securing a more general supply of electric power—the one being to link up existing undertakings (gradually weeding out those that are less efficient), and the other being the erection of large new generating stations. Unfortunately, it is impossible to start *de novo*, as if we were faced with a new problem. If this were possible there would be no question that the correct solution would be to make a beginning with large power stations and a comprehensive distribution system. This, however, is not possible, as a very large amount of capital has already been sunk in electricity supply, and this cannot be disregarded. We think there is no question that a good deal can be done by means of interlinking, but it is important that this method should only be considered as a step in the direction of progress. A better result may be obtained by means of considerable scrapping than by a system of simple evolution. A large new power station would be in a position to show better results than most existing power stations, because these are hampered, on the one hand, by a certain amount of old and inefficient plant, and, on the other hand, by lack of facilities for a good supply of condensing water. It is pointed out in the report that most municipal stations are necessarily badly placed from the point of view of the highest efficiency, because the site has been restricted to the area of the local authority. Such means as have been adopted may be sufficient for dealing with, say, 20,000 kw., but would be insufficient for 100,000 kw. This is true also of many stations belonging to companies. In these matters it is necessary to look well ahead and to think in large figures; otherwise there will necessarily be continued waste and the extension of inefficient stations, or even of stations which are comparatively efficient, but which cannot hope to become very large power stations such as this country requires if we are to have the best results.

Lastly, there is the thorny subject of private enterprise versus municipal control. Complete success cannot be expected unless the controlling organisation is able to operate over a large area. For example, the success obtained on the north-east coast would never have been secured by a local authority because its area would have been too restricted and a combination of authorities does not lead to satisfactory working. The suggestion in the report is that the organisation should take over all existing stations and mains. This would be a sweeping change, and will probably arouse much opposition. We doubt if it is necessary to go quite so far. What is essential is that existing generating stations should not be left free to continue generation and to continue to extend when it is not to the advantage of the general supply. As to management, undoubtedly initiative and resource are essential to success. It, therefore, seems to us that private enterprise is desirable, though perhaps not necessarily applicable to the whole of the country; or, if it is felt that there are certain disadvantages in private enterprise, that these difficulties should be eliminated by the principle of companies working under Government control. The present report makes out a strong case for drastic alterations, and it remains to be seen how far these will be endorsed by the Board of Trade Electric Power Supply Committee. The latter includes several members who are essentially municipal in their views, whilst the Coal Conservation Sub-Committee does not include such representatives; but we hope, nevertheless, that broad views will be adopted in framing the Board of Trade report, which is awaited with the keenest interest and with some impatience.

Reviews.

A National System of Economics. By J. TAYLOR PEDDIE, F.S.S. (London: University of London Press, Ltd.) Pp. xxv. + 299. 5s. net.

In this work, Mr. Taylor Peddie discusses economic principles in relation to the circumstances that have arisen since the outbreak of war, especially in connection with the Paris declarations. The declarations are reproduced in full. The author suggests that a necessary element in a national system of economics is the establishment, not merely of trade committees but of a Ministry of Industry and Commerce. A diagram is presented showing how in such a system the various factors, Law, Defence, Foreign Diplomacy, Education, &c., are to be linked with the manifold subsidiary elements involved in production, trade and import duties.

The book contains nine chapters. The earlier ones analyse war conditions and consider the steps necessary to make the Paris declarations effective. The problem of the inflation of prices and its relation to London's position as a free market for gold are discussed, and Sir Edward Holdern is quoted to the effect that there is reason to hope that London will continue to be the financial centre of the world.

We come next to a series of chapters dealing chiefly with labour, wherein the author suggests various principles to be

followed in securing co-operation, and endeavouring to balance the doctrine of the economical survival of the fittest, with the moral responsibilities of mankind. Modern machinery is considered in relation to Marxian theories. The author insists strongly on the minimum wage as the only solution of the labour problem. Special chapters are devoted to agriculture and transportation, and finally we have an analysis of various economic systems, the author attaching special importance to that of Frederick List, on which Germany's national system of economics is stated to be based.

Practical Safety Methods and Devices, Manufacturing and Engineering. By G. A. Cowee. (London: Geo. Routledge & Sons, Ltd.) Pp. ix. + 434. 12s. 6d. net.

The author of this work, as manager of the bureau of safety of a large insurance company in the United States, has had opportunities of judging the need for the study of protective devices in industry. In the preface he states that industrial accidents cost the United States 35,000 lives and 350,000 serious injuries each year, while the annual number of minor accidents exceeds 2,000,000. The view that accidents are inevitable in industry is a superficial one. The experience of insurance companies shows that most accidents are avoidable, and therefore the study of safety devices and measures may be expected to bring about a material diminution in mishaps.

Such measures are fully described by the author in a series of 27 chapters, accompanied by 127 illustrations. He traces the growth of the "Safety First" movement in the United States and explains the practice of many leading concerns in establishing safety committees, on which employers and workers co-operate. Typical guards for belting, danger-signs and safety belt-shifters, &c., are illustrated. Special chapters are devoted to precautions against fire and safeguards against electrical shock, &c.

The author deals successively with detailed factory operations, transmission, machine tools, grinding and wood-working machinery, iron and steel work, and processes of handling and storing material.

Special chapters are also devoted to steam and electrical railways, mining and explosives. Finally there is a discussion of miscellaneous injuries and instruction in first aid.

The paper and printing are excellent and the liberal use of illustrations is very helpful in a book of this kind. The suggestions appear to be conveyed in a readable and practical way, and the work may be recommended to all concerned with factory and industrial management.

Thomas Alva Edison. By Francis Rolt-Wheeler. (London: Macmillan & Co.) Pp. ix. + 201. 2s. net.

It is a little unfortunate that when a technical man becomes a popular hero his life should be written by authors who are unacquainted with technical matters. In such cases the lay author lays stress on technical points which have little value or are completely wrong, and thereby the value of the work suffers. Where there is so much hearsay, as there often is in American literature, it is always desirable to be on the safe side. As an example, we may mention the story related in this book to the effect that Mr. Edison, when he wished to know the volume of the glass bulb of an electric glow-lamp, submitted the problem to several mathematicians, who duly worked it out and came to somewhat differing conclusions. Mr. Edison believed in none of the mathematicians, but promptly constructed a number of tin cubical boxes of various sizes, filled the bulb with water, emptied it in turn into the various cubes until he found one that was practically filled by the water, and then calculated the contents! To the average schoolboy who has been taught a little elementary physics this story will seem humorous, and even the schoolboy will conclude that either Mr. Edison is not so sharp a man as he thought or the biographer has been led astray. We incline to the latter view. Leaving such details out of account, however, our readers who desire some light literature for Christmas will be able to pass an interesting hour or two in glancing over the stories, many of which are now familiar, of the early life of Mr. Edison, and will reach the conclusion that he deserved the success which he has achieved.

The Aviation Pocket Book. By R. Borlase Matthews. 5th edition. (London: Crosby, Lockwood & Son.) Pp. xix. + 300. 4s. 6d. net.

The science of aviation has advanced so rapidly that it is high time this very specialised branch of engineering possessed its own recognised pocket-book. The want has been supplied by Mr. Matthews, and the fact that the book has reached its fifth edition is evidence of its popularity.

The book is divided into 12 sections, the first of which deals with the fundamental phenomena on which aviation depends, such as the pressure experienced by surfaces in moving through air, distribution of pressure, centre of pressure, &c. Section II. includes questions of stability and some data in regard to aerial flight. Sections III.-V. give particulars of materials, data on elasticity, wires and fabrics; the design of air screws; and the usual information in regard to engines, including particulars of these in common use on aircraft, notes on tests. Section VI. gives brief descriptions of typical machines, while the remainder of the book deals with piloting, meteorological conditions, scouting, &c. A glossary and conversion tables conclude a useful volume of convenient size.

La Chimie des Eléments Radioactifs. By F. Soddy. Translated from the English by [illegible] (Paris: Gauthier-Villars.) Pp. 173. [illegible]

This book is a translation of Prof. Soddy's well-known work on the "Chemistry of Radioactive Elements," and, therefore, does not call for particular comment. We do not doubt that this translation will be of considerable value to French readers [illegible] a specialised branch of physics.

The Metric System.

On Dec. 1[illegible] a discussion [illegible] was held at the Institution of Electrical Engineers [illegible] to determine whether the adoption of the [illegible] would be to the advantage of the electrical industry [illegible] by Mr. L. B. Atkinson and Mr. A. J. S[illegible] [illegible] Dec. [illegible] sion which followed.

[illegible]

[illegible] the matter at [illegible] pulsory.

[illegible]

theirs. As long ago as 1862 a Select Committee of the House of Commons agreed that it would involve almost as much difficulty to create a new decimal system as to take the existing metric system. Manufacturers had not yet aggressively demanded the metric system, and that could only be due to their having regarded only their own convenience, and not the international aspect of the case. The longer it were delayed the worse the trouble would be. National interest required that the question should be looked into more seriously than hitherto. Mr. Atkinson asked whether it was wise at this moment to adopt the system with which our enemies were more familiar than we were. The Germans adopted the French metric system immediately after the Franco-German war, because it appealed to them as being the best system. After the war our sources of production might be satisfactory, but there might be no correspondingly increased demand for our goods from overseas. He agreed that the change would practically be effected in getting back to normal.

Mr. W. H. MASSEY, who remarked that the fact that he was getting old and that he was not an orator might militate against the presentation of his ideas in the best sequence, said he spent his childhood in a country using the metric system. At the age of 13 he had to learn the British weights and measures. Later he went to Germany, where he had to re-learn the metric system, and still later he came to England, and had used the English system ever since. He confessed that the second change to the metric system was the hardest. The metric system was the simplest on paper, but he did not think it would be of any particular use to anyone in the particular branch of electrical engineering in which he practised. An ohm mile was half a pound of copper per yard. Could Mr. Allcock put that into metric? There was no need to make our goods to a metric scale because we sold them in a metric country. He feared the compulsory use of the metric system would not be successful. The system has suited scientists, but did not affect the ordinary working men. In France they talked of sous and two sous and the pouce (or inch), and not of the centimetre. It was simpler to tell a man to fetch a [illegible] 7 × 2 plank. The square of the diameter of a pipe in inches came to a number of gallons. Could Mr. Allcock give them anything as simple as that? A cubic inch of water gave a cubic foot of steam. To calculate the result of 7d. a day (assuming this to be a soldier's pay) for a year, 1½ times the number of pence per day would give the £'s = £10 10s., and then two times 7d. had to be added. That kind of thing could not be done in metric. He was absolutely neutral, however.

[illegible] said he was not in a position to deal with the matter from a practical point of view. The educational had always seemed to him one of the most important points of view. He had always pitied the young British boy who had to get into his head the many figures of the British tables, and of course could not keep them there but had to keep them in a ready reckoner in his pocket. He could not see the point of calculating how much 7d. a day was for a year. If a soldier got 7d. a day he would call it 70 centimes, and for 100 days 70 × 100 = 7,000 [illegible]. If the duodecimal system were adopted, and the figure 12 were written "10," there would have to be special figures for 10 and 11, and 10 would be read "12." Both the authors had pointed out the misunderstanding that had existed in the minds of the British nation as regarded "decimalisation" and "metricalisation." Decimalisation seemed to him one of the most fundamental things. The [illegible] into 10 parts, and that these parts were [illegible] 10 appealed [illegible]. The change would probably be less inconvenient to Britishers if a decimalised British [illegible] adopted. [illegible]

[illegible]

Mr. [illegible]

[illegible]

ings of them must exist in metric dimensions, and many shops were working to them without trouble. In 1913 we sent to metric countries 281,000 tons of electrical, pumping, agricultural, mining, textile and unenumerated machinery, boilers and machine tools to metric countries, and 203,000 tons to English system countries, and it would seem hazardous to prejudice our trade with the latter group unless they could be got to come into line. We sent twice as many motor cars and cycles to English standard countries as to metric countries, and of scientific instruments £428,000 worth to English system countries compared with £271,000 worth to metric countries. As the British standard places counted for about twice as much as the others, one should go carefully before making a change for sentimental reasons.

Mr. D. ADAMSON said the subject of linear measurements was sufficient for discussion for the present. Mr. Atkinson had laid down a proper course of progress by which the metric standard of linear measurements could ultimately be attained; but there were many steps to be taken before that would be reached, and they would take a long time. Men were making parts to fit something which was made some time ago. Agricultural engineers got orders for parts for machinery 50 years' old. That could not be done if the round figure measurements for metric sizes were adopted. The adoption of the metric units meant throwing overboard everything Whitworth had established in the way of interchangeability of parts. The textile machinery trade of Lancashire were unanimously opposed to the compulsory adoption of the metric measurements. If it became compulsory, a day for scrapping the old plant would have to be fixed, as new parts for it could not be supplied. His firm manufactured 150 sizes of tools, varying from 1 ft. 6 in. to 10 ft. 6 in. diameter. They had half a dozen corresponding lists of German makers and those lists were arranged in regular metric steps, and, instead of 150, they contained about 50 sizes over the same range. The Germans made the customer take something approximate, which he would not take from an English maker. If 100 of the 150 sizes were abandoned, it meant £10,000 worth of tools would be thrown away, and money would have to be found to replace them. Would they be able to sell their goods any cheaper or better abroad under the metric system? Would an engine be better or cheaper for being made to metric dimensions? He protested against this debatable question being raised at this time, when shop managers had as much as they could do with production and labour questions. The jewellers and others had adopted metric units voluntarily. Let engineers also adopt them when they found it convenient.

Mr. E. G. C. BARTON said in Australia they had asked for the metric system for a long time, but the British Ministers had slammed the door. There were going to be more metric countries, and Asutralia was going to be one of them. Americans said if England adopted the metric system America must do it also. Australia had passed the necessary resolutions through Parliament for its adoption, and were waiting for the old country to move. They would not wait for ever. It must be done compulsorily. Mr. Dickinson, chairman of the Bath Chamber of Commerce, had told him that he received an intimation not long ago that the metric carat must be adopted. The jewellers thought they would be ruined, but at the end of a week they would not have gone back to the old system. He found everybody in England agreed that we must have the metric system some day, but did not want it in their day.

Mr. H. M. HOBART said the conditions in regard to the adoption of the metric system did not seem any more encouraging in America than here. One speaker thought it might be reached here in 10 years. One dare not contemplate what might happen in 10 years. These were the days of doing great things in a short time. The metric system was much more generally held to be the best system than appeared on the surface. He believed in it, but he was obliged to make his reports in the British units. Thousands of engineers were in the same plight. Nothing could come of their belief in the metric system without collective effort. Bodies such as that Institution were the bodies that could take the steps that would enable progress to be made. He thought it was the duty of the older men to take their mandate from the young men, who would be filling their places in 20 years' time.

Capt. D. H. KENNEDY said that if nothing were done as the result of that night's discussion it would be a reproach to that learned society. He had had to report on the construction of aircraft and the difficulty of obtaining lengths of copper tube for aircraft. Orders had been sent to the tube manufacturers in various ways. They got orders for, say, 300 ft. of tube 1 in. external diameter and 18 legal S.W.G.; they got orders in terms of internal diameter, and legal S.W.G. in terms of Ball and Whitworth gauges, and in terms of metrical external diameter and of metrical internal diameter. The British manufacturer went on booking the orders, and when he got a big enough order made the die and mandril and went on with the job. If he did not get a big order he booked a small one, and kept it in the hope that a big one would come along. A drastic remedy was applied, and the people ordering were told that they must order in a certain way. The moral was that it was up to them to make up their minds to use one system, and it must be made compulsory. It was wrong to say our children must learn the obsolete weights and [illegible] because we had had to learn them.

Mr. H. [illegible] said Mr. Massey had begun his speech by apologising for the fact that he was getting old. With great respect, he (Mr. Rottenburg) thought the fact that Mr. Massey found the second change (to the metric system) the harder explained a good deal. As people got older they got into a position in which they could decide whether an [illegible] should be changed, but as they approached that honoured [illegible] they were losing the mental suppleness and activity which would have made the change appear a possible if not easy thing. They should [illegible] the young men's view of the situation. The question of the [illegible] between our getting into metric markets and the

metric nations getting into the non-metric markets was too small a view of the subject. The question was whether the adoption of the metric system would produce such increased efficiency and speed as would help us to get into those foreign markets. He did not think the mere using of the metric system would do so. If they had a transition stage there would be extreme confusion, and it would afford opportunities for dishonest practices.

Mr. J. ROBERTS said in British Acts of Parliament words often had two meanings. A ton of coal, in addition to meaning a weight, also meant the quantity one would have to burn. He thought Mr. Atkinson had adopted a mistaken policy in taking the meaning of a word by some specification, and not looking at the whole surroundings and finding out how it was actually used. It was easy to [illegible] the measures of land. In Ireland the measure of the acre had been changed to that of the English acre, and in documents of 20 or 30 years ago measurements were usually given in both English and Irish measures. With regard to coinage, the new and old values could be in the coins until the people got accustomed to the new values. In Egypt he had seen thermometers marked with both the Fahrenheit and Centigrade scales, and even Ethiopian carriage drivers submitted to the passengers a chart showing distances in British and metric terms, and the fares in two kinds of currency.

Report on Certain Methods of Producing Vacuum.

The first report on this subject to the Council of the North-East Coast Institution of Engineers and Shipbuilders has been drawn up by Messrs. E. L. Orde, C. W. Cairns, M.Sc., and J. Morrow, D.Sc.

The report is illustrated by numerous diagrams, and full results are given. It is concerned with reciprocating pumps only (other types being reserved for later reports), the tests being carried out on plant by Richardsons, Westgarth & Co., at their Hartlepool Works.

From a technical standpoint the report demonstrates beyond question that no mechanical contrivance is so simple and so efficient as a steam jet for compressing a large volume of highly attenuated air through a small degree of compression, and, as is already well known to engineers, a reciprocating air pump is a very efficient means for discharging moderate volumes under a high degree of compression. Consequently, the correct solution of the problem of air discharge from a condenser is to withdraw a large volume of aerated vapour by means of one or more steam jets and compress it through the range of compression at which the steam jet works with very high economy, and then [illegible] pressure that an air pump or other [illegible] the atmosphere also with very high economy.

It is, further, [illegible] that [illegible] whilst the use of steam jet has hitherto been [illegible] with the production of high vacuum such as is required for steam turbines, the report makes it clear that, for the production of any vacuum such as is standard for the reciprocating engines of cargo vessels, the jet system may be even more effective.

From the standpoint of economy the effects of the adoption of the jet system are evidently extremely [illegible]. As is well known, a reciprocating air pump is a highly [illegible] auxiliary on a steamship. Its cost depends on its size, [illegible] and less on its speed of working, and its economy in operation on the quantity of steam that it uses. The report shows that for a given duty the combination of a steam jet on the kinetic system will [illegible] speed of a given pump to be reduced from 60 strokes per minute to 30, and the consumption of steam to be reduced by one-third, the pump [illegible] remaining exactly as at present. Alternatively [illegible] independently driven pumps may be made smaller for a given duty, or, in the case of cargo vessels in which the air pump is driven by the main engines, the entire economic influence of the steam jet may be utilised in reducing the size of the main condenser and the pumps in connection therewith. [illegible] the [illegible] of the report.

Legal Intelligence.

The Kensington and Notting Hill Joint Station Dispute.

On Dec. 19 Mr. [illegible]

Mr. [illegible], K.C., and Mr. [illegible] Notting Hill [illegible] Kensington [illegible]

Mr. TOMLIN, K.C., [illegible]

entered into. The agreements related to the erection and maintenance of a joint power station, and the nature of the question in dispute between them was substantially as to whether or not the Notting Hill company in certain circumstances had failed to take from the joint generating station erected by the companies the amount of electrical energy which, by reason of their obligations under the agreement and the special act, they were bound to take. It was a question of alleged breach of contract. It was alleged against the Notting Hill company that they ought to have taken more current than they had taken from the joint station, but his case was that one of the purposes for which it was alleged they ought to have taken current and for which they had not taken current was a purpose that was outside of the special Act altogether, and for which it would never have been possible for the generating station to have supplied current consistent with the provisions of the Act. Under the agreement it was provided that the output of 1,800,000 watts might be used by the companies as they should require, but it was afterwards agreed between the two companies that the Kensington company should not be entitled to use more than 1,200,000 watts without the consent in writing of the Notting Hill company, and the Notting Hill company should not be entitled to use more than 600,000 watts without the consent in writing of the Kensington company. If the joint station was unable to supply the total output required the companies could take the available output in accordance with the proportions indicated, or in such proportions as might be agreed upon from time to time. Under this agreement the Notting Hill company had taken their maximum, and yet they had been fixed with damages in the arbitrator's award for not having taken more.

Mr. VESEY KNOX, K.C., interposing for the Kensington company, said that the joint station had become much larger.

Mr. TOMLIN said he was instructed that the Notting Hill company had taken a third of the increased output. After dealing in detail with the various agreements and the provisions of the Acts conferring the powers on the companies, incidental to the erection of the joint power station at Hammersmith, Mr. Tomlin said his case was that the Act authorised the acquisition of land and the construction of the joint station for one purpose only—for supplying energy within the areas of supply for the time being authorised, and nothing outside of those areas fell within the scope of the agreements, and any agreement, therefore, for the use of electrical energy supplied by the joint station for some purposes outside of that would have been *ultra vires*. The Notting Hill company had had damages awarded against them for not taking from the joint station energy for a district that was outside of the statutory area. The fact was they could not have supplied that district from the joint power station except at enormous commercial loss, as it involved a low-tension continuous-current supply and they could not and would not have done it.

Mr. VESEY KNOX, K.C., interposing, said that the arbitrator who had made the award was an experienced electrical engineer; the Notting Hill company set up before him the case that they could not possibly have taken this supply from the joint power station and the arbitrator found against the Notting Hill company on that contention. The case for the Kensington company was that the supply could have been and should have been given from the joint station.

Mr. TOMLIN said that [illegible] would not have been able to supply that district at all except for the fact that they were able to make arrangements for the supply from the Metropolitan Electric Supply Co. The district in question was the Kensal New Town [illegible] 1909. The effect of the finding of the arbitrator was that the Notting Hill company had to take the power for any purpose connected with any business they might be concerned with from the joint generating station, except as to what they could get from its own [illegible] place, Notting Hill. So that the effect of the finding was that, suppose the company was invited by the owner of a [illegible] coast who had also complete control of the whole area, including all [illegible]

[illegible]

Mr. VESEY KNOX, K.C., [illegible]

that Mr. Tomlin was not entitled to put before the Court the statement of facts on which to found this argument. The maximum power taken last year by both the companies was less than half of the capacity of the joint station, and there had always been an enormous surplus of current. There never had been any question of limitation of output. Mr. Tomlin had claimed that the Notting Hill Company had taken 600,000 kw., and had done all that they were required to do; but that was a misapprehension of the object of the relevant clauses, as these dealt with the limitation of the maximum demand. The clause limited the amount which during a certain specified period could be taken from the joint station. Mr. Tomlin's statement that they had always taken 600,000 kw., if it meant that this had been taken throughout the year, was absurd. If it meant that they had always taken that quantity at certain times of the year, it might be so; but it had nothing to do with the point before the Court. The joint station had at all relevant times been ready and willing to give any supply required by the Notting Hill Company.

Mr. Justice McCARDIE: It seems to me Mr. Swinburne must have found that the joint station was willing to supply, otherwise he would not have awarded damages.

Mr. VESEY KNOX: Yes, ready and willing to supply as much as was required.

Mr. Justice McCARDIE said that difficult matters were arising with regard to the facts found by the arbitrator. If they were to get on with that hearing they must try to formulate some common basis of facts.

Mr. TOMLIN said that the capacity of the joint station had been increased from time to time, and, instead of being limited to 1,800 kw., it was now 9,000 kw. His clients had, in regard to the total, always taken the fair proportion provided for in the agreements. There had been times when the station had not been in a position to give them all that they wanted.

On Friday Mr. TOMLIN, K.C., replied on behalf of the Notting Hill Company. He said the root question in the case was what was the contract the Notting Hill Company had entered into and what had they contracted to do? If they had contracted to do something that was within their powers, and had not carried it out, they were liable in damages; but if it was not within their powers, they were not liable in damages, because there was no contractual obligation of which there had been a breach, as they never had the contractual capacity to bind themselves by such obligation.

Mr. Justice McCARDIE, in the course of Mr. Tomlin's reply, observed, amid laughter, that he had not yet seen one definite or illuminating feature of the case.

Mr. TOMLIN, K.C., argued that upon the agreement there were two limitations—the supply was to be within the statutory area, and there was to be "a reasonable amount" taken. As the Kensal Town area was outside of the statutory area, if he was right that concluded the whole point in his favour. Counsel also submitted that it could not be contended that as the arbitrator had found damage there was an end of the matter. The award had been framed in an alternative sense by Mr. Swinburne. The Kensington Company could only found a claim on a breach by the Notting Hill Company of a valid obligation, and they had to show that there was an obligation of which there was a breach, and in respect of which a claim for damages arose. There had been a supply to an area outside the statutory area which was ultra vires, and the Kensington Company were now seeking to say that the Notting Hill Company were bound to take the supply from the joint station "for any purpose," even if it was illegal or ultra vires. The argument really was, "You have contracted on something which is illegal, and we ought to have something out of it; we ought to have a finger in the pie." That was an [illegible] position.

Judgment was reserved.

The Osram-Robertson Lamp Litigation.

[illegible]

[illegible] Corporation.

[illegible]

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1916 SPECIFICATIONS.

10,882 ELECTROMOTORS, LONGBOTTOM & GREENHALGH. Dynamo-electric machinery (2/8/16. Patent of addition not granted.) 110,916

11,503 BRITISH INSULATED & HELSBY CABLES & BLADES. Electric cable connecting boxes, fuse switch boxes, dividing boxes and the like. (15/8/16.) 110,919.

15,351 MASON, C. T. Interrupters for ignition systems. (30/6/15.) 101,980.

15,357 LEVIN, I. H. Electrolytic gas-generators. (20/12/15.) 120,933.

15,623 GWYNNES (LTD.) & HUMPHREYS, H. Means for attaching ignition wires to sparking plugs of rotary aeroplane engines. (2/11/16.) 110,796.

15,675 B.T.-H. CO. (G.E. Co.) Wireless telephone systems. (2/11/16.) 110,924.

The device comprises the usual cathode, anode and grid, and a second grid which may be operated entirely independently of the first grid. The high-frequency current is produced by coupling the circuit, which includes one of these grids, with the plate circuit, and the control of the circuit is secured by applying the potentials obtained from the telephone currents to the second grid. The control exercised by this second grid may be of the same order of magnitude as the control exercised by the first grid, although the potentials applied thereto may be much less than those acting upon the first grid.

16,215 LONGFORD, LONGFORD & CLARK. Sparking plugs for internal combustion engines. (13/11/16.) (Cognate application, 17,885/16.) 110,950.

16,382 CLOTHIER, H. W., & REYROLLE & CO., A. Electric switchgear. (5/11/16.) 110,808.

16,513 MASON, C. T. Ignition dynamos. (19/6/15.) 102,266.

16,591 STIRK, STIRK, STIRK & STIRK. Two-way master switches for actuating sets of contactor switches for reversing motors of planing machines and other reciprocating machines. (20/11/16.) 110,958.

16,610 IGRANIC ELECTRIC CO. & BERGMANN. Electrical switchgear. (20/11/16.) 110,959.

16,990 MARKS. (Mercury Mfg. Co.) Electric tractors. (27/11/16.) 110,968.

17,111 HENWOOD & LANE. Solenoid motor. (29/11/16.) 110,969.

17,275 CLOAKE, H. J. (Cloake, C. S.) Pocket flash lamps. (1/12/16.) 110,823.

17,981 COMSTOCK & TECHNICOLOR MOTION PICTURE CORPN. Method of controlling and apparatus for producing electric arcs. (14/12/16.) 110,982.

Relates to the method of producing an ionic discharge in a gap between opposed electrodes comprising creating a suitable potential gradient along the gap, and creating in the region of the gap a stream of magnetic flux angularly shifted with respect to the axis of the gap, so that the discharge is distributed over the end of one electrode in such manner that a steady incandescent area is maintained on the end of the electrode in substantially normal relationship to the axis of the electrode.

18,661 STEVEN, J. A., & GOTTERSON, R. J. Control gear for alternating current electric motors. (30/12/16.) 110,836.

1917 SPECIFICATIONS.

528 MURRAY. Electric welding machines. (8/3/16.) 104,675.

1,017 HENLEY'S TELEGRAPH WORKS CO., W. T., & POVEY, R. Suspender for electric cables and the like. (20/1/17.) 110,848.

1,482 TAMMADGE & TAMMADGE. Electric dry cells. (30/1/17.) 111,005.

1,490 GILBERT CO., A. C. Toy electric motor. (18/4/16.) 105,742.

2,109 MASCHINENFABRIK OERLIKON. Means for securing an insulator to a base plate (12/2/16.) 1[illegible]4,177.

2,930 CHLORIDE ELECTRICAL STORAGE CO. & DEAN, H. Electric cable connectors. (27/2/17.) 11[illegible],858.

3,236 ELLISON, G., & ANDERSON, J. Electric controllers and the like. ([illegible]/3/17.) 110,8[illegible]2.

3,464 CONNER, M. S. Magneto-electric machines for ignition in internal combustion engines. (9/3/17.) 110,8[illegible]4.

3,485 QUASI-ARC CO. & TWEEDALE. Electric welding or fusion deposition of metals. (9/3/17.) 111,026.

3,802 BEAVER, C. J., & CLAREMONT, E. A. General and electrical joints. (15/3/17.) 110,868.

5,402 FOSS, H., & PETERSEN, H. Systems for the transmission of writing and the like in facsimile. (28/4/16.) 105,914.

A method of producing the necessary current impulse at the receiving station, in which a part of the energy of an alternating current generator connected to the transmission wires is shunted by means of a contact arrangement, which is so actuated by means of the writing at the sending station that the shunt circuit is cut out by a contact pin passing over the writing.

8,589 CASSAN. Electric batteries or cells. (15/6/17.) 111,058.

8,748 ROYCE, F. H., & ROLLS-ROYCE (LTD.). Electric contact breakers. (18/6/17.) 110,891.

9,182 DELAGE, M. Y. Magneto controlling device enabling internal combustion motors to be started by hand. (1/7/16.) 107,761.

9,405 IMRAY. (Bosch.) Interrupting devices for the ignition of internal combustion engines. (29/6/17.) 111,062.

11,358 KENNINGTON. Means for controlling electric circuits. (7/8/17.) 111,071.

Volunteer Notices.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Oxford-street, W. 1.

Orders for the Week.

Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.

Officer for the Week: Lieut. C. E. Campbell.

Next for Duty: Lieut. W. J. A. Watkins.

Drills. Week ending Jan. 5, 1918.

[illegible] No. 3 Company, Recruits, Signalling, 6.30-8.30.

[illegible] Lecture on Demolition, 6.30, by Capt. [illegible]. Physical Drill, 7.30.

Wednesday, [illegible] Company Drill, Knotting and Lashing, 6.30-8.30. Recruits, 6.30.

[illegible] Company Drill, Knotting and Lashing, Recruits, [illegible] Recruits, 6.30-8.30.

Friday. Musketry, 5.30-8.0.

[illegible]

[illegible] stated.

[illegible]

[illegible] will be allowed in the Officers' [illegible] during the time [illegible]

[illegible] in connection with the Companies.

COMMERCIAL & INDUSTRIAL SECTION.

Patents and Trade Marks.

The members of the Patents, Trade Marks and Designs Section of the London Chamber of Commerce have had under consideration the Bills for amending the Patents and Designs Act (1907) and the Trade Marks Act (1905), and committees were appointed to take action to secure certain amendments in both measures.

The section expressed the view that any legislative proposals necessary to deal with the question of the prolongation or extension of patents should be embodied in a separate measure and passed into law as speedily as possible, and that as many of the other proposals in the Patents Bill are of a contentious nature they should be embodied in a separate measure. Objection was taken to certain clauses of the Trade Marks Bill, more especially to Clause 7, providing for the removal from the register of word trade marks used as names of articles.

* * * *

British Firms and Australian Income Tax.

The Australian Association of British Manufacturers and their Representatives has issued a statement in regard to this matter.

It is stated that although Sec. 15 of the Federal Income Tax Assessment Act has been repealed, it does not follow that in all cases returns are not required in regard to sales in Australia on account of overseas principals. The question depends upon whether the business is within the meaning of the law carried on in Australia on account of overseas principals, and in any case where a business is so carried on in Australia it is necessary to ascertain the amount of profit accrued in Australia from the business. The Acting Commissioner of Taxation states in a memorandum that the points to be considered in deciding the question are (1) the place where the contract is accepted, (2) the place of delivery, and (3) the place of payment, and the trade is deemed to have taken place in Australia when two or three places are in Australia.

* * * *

An Air Inventions Committee.

Lord Cowdray recently appointed an Air Inventions Committee for the purpose of investigating inventions and for developing and putting in operation as soon as possible any invention which promises to add to the efficiency of aircraft.

The Committee, whose address is 2, Clement's Inn, London, W.C. 2, is composed as follows:—Mr. Horace Darwin, F.R.S. (*Chairman*), Major-General [illegible], C.B., C.M.G. (*Vice-Chairman*), Sir Dugald Clerk, K.B.E., F.R.S., Sir Richard Glazebrook, F.R.S., Prof. H. L. Callendar, F.R.S., Prof. C. H. Lees, F.R.S., Prof. [illegible], F.R.S., Mr. L. Bairstow, C.B.E., F.R.S., Lieut.-Commander Wimperis, R.N.V.R., Major G. Taylor, R.F.C., Capt. B. M. Jones, R.F.C., Capt. A. V. Hill (Munitions Inventions Department), Mr. [illegible] and Mr. F. W. Lanchester.

* * * *

Imports for November.

The following are official values of electrical machinery, material and apparatus imported into this country (a) during November, 1917, and (b) the aggregate figures from Jan. 1 to Nov. 30, with increase or decrease compared with corresponding periods of 1916:—

[illegible]

£15,127), (*b*) £777,281 (increase £18,481); and electrical machinery unenumerated, (*a*) £50,884 (decrease £4,144), (*b*) [illegible] (increase £47,546); telegraph and telephone cables, submarine, (*a*) £44,664 (increase £25,322), (*b*) £216,189 (decrease £207,299); other than submarine, (*a*) £53,195 (increase £17,724), (*b*) £615,719 (increase £139,812) telegraph and telephone apparatus, (*a*) £14,278 (decrease £11,048), (*b*) £243,091 (increase £7,576); other electrical wires and cables, rubber insulated, (*a*) £4,797 (decrease £30,148), (*b*) £178,041 (decrease £338,236); with other insulation, (*a*) £9,581 (decrease £29,482) (*b*) £262,403 (decrease £459,029); carbons (*a*) £701 (increase £319), (*b*) £22,139 (increase £12,349); glow lamps, (*a*) £9,379 (decrease £13,831), (*b*) £122,293 (decrease £58,489); arc lamps and searchlights, (*a*) £716 (decrease £455), (*b*) £23,314 (increase £13,865); parts of arc lamps and searchlights (other than carbons), (*a*) £2,976 (decrease £3,632), (*b*) £74,719 (increase £53,009); primary and secondary batteries, (*a*) £7,557 (decrease £8,173), (*b*) £138,126) decrease £108,743); meters and measuring implements, (*a*) £10,084 (decrease £6,165), (*b*) £124,598 (decrease £70,054); transformers, (*a*) £3,344 (decrease £9,160), (*b*) £65,213 (decrease £34,956); switchboards, (*a*) £6,265 (increase £5,815), (*b*) £38,854 (decrease £15,954); electrical goods and apparatus unenumerated, (*a*) £41,680 (decrease £34,338), (*b*) £640,203 (decrease £38,386). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £209,217 (decrease £100,552), (*b*) £2,764,902 (decrease £1,104,535).

* * * *

Electrical Machinery in British Malaya.

A section of the annual report of the Senior Warden of Mines in the Federated Malay States is devoted to the inspection of electrical plant in use in the country. In the F.M.S. alone there were 80 installations of generating plant in 1916, of which 50 were in the State of Perak and 22 in Selangor.

The employment of electricity was as follows: Mining, 7,918 kw.; agricultural, 200 kw.; general, 228 kw.; and Government, 10 kw. For power 7,936 kw. was used, and for lighting 2,865 kw. Government plant supplied most of the lighting. The above figures refer only to generating plant driven by prime movers. There is, in addition, motor-generating plant in use of about 400 kw. capacity. The horse-power of motors employed aggregates about 10,250 against 9,000.

The statistics of the imports and exports department of the Straits Settlements show that the United Kingdom supplies most of the electrical machinery and accessories in use in British Malaya. For four years the total value of imports and exports was as follows:—

	Imports.	Exports.
1913	£73,978	18,824
1914	50,898	[illegible]
1915	39,690	[illegible]
1916	44,203	[illegible]

The United Kingdom's share of the 1914 imports amounted to £39,408, Germany's to £4,310, and the United States to £2,07[illegible]. The [illegible] for 1913 are compared below with two war years:—

	1913.	1915.	1916.
United Kingdom	[illegible]	[illegible]	[illegible]
Germany	9,474	221	—
Denmark	[illegible]	[illegible]	[illegible]
Japan	[illegible]	[illegible]	[illegible]
United States	[illegible]	[illegible]	[illegible]
Italy	[illegible]	[illegible]	1,040
Sweden	[illegible]	—	—
Netherlands	[illegible]	[illegible]	[illegible]

[illegible]

South African Imports.

[illegible]

ELECTRICITY SUPPLY.

GENERAL.

Barnes.—The salary of the assistant electrical engineer has been increased to £300 per annum, plus 7½ per cent. war bonus. The salary of the electrical engineer (Mr. C. S. Davidson) is to be taken into favourable consideration.

All employees of the electricity department, except boys under 18 years of age, have been granted a 15s. increase upon pre-war wages, and boys under 18 years of age will get 7s. 6d. a week.

Barrow-in-Furness.—Sanction to obtain tenders for another turbo-alternator has been applied for.

Birmingham.—At the last meeting of the Electric Supply Committee, Mr. Ernest John Jennings, the secretary of the St. Marylebone electric supply undertaking, was selected to be recommended to the City Council at their meeting on the 8th prox. for appointment as secretary of the electric supply department, in succession to Mr. Howard Foulds, who leaves at the end of the year to take up a new position in London.

At the same meeting the Lord Mayor presented to Mr. Foulds a copy of a resolution engrossed on vellum, and signed by the Lord Mayor and the chairman of the Committee.

The resolution, which was passed unanimously, recited that the Electric Supply Committee received with great regret the resignation of Mr. Howard Foulds as secretary of the electric supply department, and that they desired to place on record their high appreciation of the energy, ability and tact with which he had successfully performed the duties of that office since his appointment. This period (over seven years) had witnessed an exceptional development in the operations of the undertaking, first owing to the extension of the city and the absorption of the Aston Manor and Handsworth electric supply undertakings, as well as carrying the operations of the department into a large portion of the areas of Yardley and Kings Norton; and, secondly, owing to the exceptional demand for electrical energy which had arisen during the progress of the present war. The work that had fallen upon the shoulders of Mr. Foulds had been heavy and responsible, and the Committee were pleased to recognise that he had fulfilled the demands made upon him to their complete satisfaction. They considered that the department had gained in efficiency by his efforts, and he would leave behind him a record of work which would be remembered and appreciated by the Committee and his colleagues, and they assured him that he entered upon his new appointment with their best wishes for his future prosperity.

Bitterne.—South Stoneham Council have authorised Southampton Corporation to supply electric current in this district.

Electricity Supply in the Midlands.—The Corporation of Newark have decided to support Nottingham City Council in their efforts to have one of the distributing centres for electrical supply at Nottingham.

Extension of Time Orders.—The Board of Trade has extended by one year the times specified in the undermentioned Acts:—

[illegible] and Walmer Gas and Electricity Act, 1914, and the Central London Railway Act, 1913.

Staveley.—A new company has been registered under the title of the Staveley Electric Supply Co. (Ltd.), for the purpose of carrying on at Staveley and elsewhere in the county of Derby the business of an electric supply company.

The capital of the company is £5,000, divided into £1 shares. The first directors are Mr. C. P. Markham, Dr. Josiah Court and Mr. C. W. Kendall. The number of members of the company, which is to be [illegible], is not at any time to exceed 50.

Wortley.—The Rural Council will oppose the application of the [illegible] and [illegible] Corporation for provisional electric lighting orders for the district.

ELECTRIC TRACTION.

Birmingham.—In accordance with the [illegible] of the Committee on [illegible], the Tramways Committee have decided to grant [illegible]

Tramway Control Committee.—In reply to a question in the House of Commons on the 19th inst., the Secretary to the Board of Trade stated that it had been arranged to [illegible] the Committee [illegible]

IMPERIAL NOTES.

Australia.—The Federal Government has [illegible] the proposal [illegible] at Williamstown, Victoria, [illegible]

[illegible] could, with the addition of some essential machinery, cope with the class of work required, while, with regard to labour, there is reason to believe that skilled mechanics in sufficient numbers are available. Steel plates for ships could be rolled at steel works at Newcastle (N.S.W.)

The Secretary of Electrical Exploitations and the Bureau of Special Investigations, Tokio, recently arrived in Sydney with the intention of touring the Commonwealth to make enquiries in regard to electrical undertakings, with a view to studying the Australian market for electrical machinery and equipment, in the interests of Japanese manufacturers.

In a Bill recently introduced into the Victorian Legislative Council power is sought to enable municipal authorities who supply electric current to sell, let on hire, fix and repair electric wires and fittings, motors and current-consuming devices, &c.

British Columbia.—A railway mining and power development programme, involving the early expenditure of over £1,200,000 in the Southern Okanagan and Similkameen Valleys, has been put forward recently.

The Kettle Valley Railway Co., which now owns and operates the section of the Coast-Kootenay line between Midway and Hope, will build a branch from Penticton to Copper Mountain through 14 miles of mountainous country. The Kootenay Power Co. will expend a large sum in building a high-tension power line from Greenwood, west as far as Copper Mountain, and will extend a line to Penticton for industrial purpose.

India.—The Director General of Military Works, Simla, recently invited proposals for the formation of an electric supply company at Peshawar, the Government agreeing to take a supply for military buildings.

A Government licence for the supply of electrical energy within Mhow cantonment has been granted to Messrs. Abdulhussain Haji Jiwabhoy, of Indore. The d.c. three-wire system of supply will be adopted, at a pressure not exceeding 230 volts at consumer's terminals for lighting, and 460 volts for power. The main cables, distributing mains and service lines within the area of supply are to be aerial lines. The Mhow municipality will take electric current for 342 street lamps during the period of the licence.

The report of the Tata Hydro-Electric Power Supply Co. (Ltd.) for the half-year ending June 30 states that dividends at the rate of 7 per cent. per annum, on both preference and ordinary shares, were paid for the second half of last year, and for the half-year to June 30 the directors recommend a further dividend at the rate of 7 per cent. per annum on the preference and 8 per cent. per annum on the ordinary shares. It is stated that 48,000 H.P. is now being supplied to motors in Bombay. Good progress has been made with the preparation of the new lake at Shirawata above the Ghats for the supply of additional water to the generators, and two-thirds of the new dam there has been completed.

Mica Mining in Nigeria.—Regulations (No. 35 of 1917) were made on Aug. 23 under the Nigeria Minerals Ordinance, 1916.

These regulations provide that the royalty on mica is to be 5 per cent. on such sum as the Government Inspector of Mines may from time to time assess as the local average value of mica. The area of a lease conferring the right to mine and dispose of mica is not to exceed 40 acres, and the rent for such lease is fixed at 1s. per acre.

FOREIGN NOTES.

China.—H.M. Consul at Dairen has forwarded a copy of the specification of an electric locomotive recently built at the South Manchuria Railway Co.'s works at Shakako, for the use of the Fushun mines.

It was proposed to build seven other locomotives of a similar character by the middle of the present month. It is understood that this is the first attempt to build this kind of locomotive in Manchuria, supplies having hitherto been obtained from Germany or the United States. British firms may consult the specification at the Department of Commercial Intelligence, London.

Electricity Supply on the Continent.—It is stated that there are only about 100 of the small towns in Sweden without works for the supply of electricity for light and power, and even in connection with these supply schemes have been prepared.

Between 1905 and 1914 the capacity of the various works rose from [illegible] kw. to 125,000 kw., and the total installation costs from 17,000,000 to [illegible] kroner. Electric supply progress in Switzerland, Norway and Denmark has been even more rapid. One special feature in connection with Continental electricity supply is the large use made of water power. Even the steam driven station at Stockholm is now taking steps [illegible] power from the river Dal.

Japan.—H.M. Commercial Attaché at Yokohama (Mr. Crowe) [illegible] that an Exhibition of Electrical Machinery and Appliances will be opened at Tokio on March 20 next, under the auspices of the Nippon Denki Kyokwai (Japanese Electric Association).

Mr. Crowe says that the manufacture of electrical machinery and [illegible] in Japan has undergone great development during recent [illegible]. The first electrical industry was established in Japan 30 years ago, and the object of the Exhibition is to show the progress that has taken place and to give a stimulus to further enterprise. The exhibits, which

will be confined to Japanese manufactures) will include motors, generators, batteries, and generating plant equipment; electric railway materials; telegraph, telephone and wireless-telegraph apparatus; electric lighting apparatus and accessories; appliances for the electro-chemical industry; domestic electrical appliances; industrial electrical machinery, pumps, cranes, &c.; surgical, educational and experimental electrical apparatus; and general accessories.

Lourenco Marques. The "African World" states that the Municipal Council has terminated the lighting concession, and that the service will be municipalised.

The concession for supplying Lourenco Marques with electric light, held by a French company and controlled [illegible] by the Delagoa Bay Development Corpn., was cancelled [illegible] of the high charges to the consumers—2s. 3d. per unit. The company held that this high rate was due to the fact that the Government and municipal buildings were supplied [illegible]. The concession was originally to run for 60 years, but contained a clause permitting the municipality to take it over at the end of 20 years, which have now expired, on purchasing the plant and indemnifying the concessionaires for their profits over the unexpired portion of 30 years. The capital of the company is over £80,000.

Venezuela.—A report published by the American Bureau of Foreign and Domestic Commerce, states that there will be a marked development in the demand for machinery and materials.

American manufacturers are warned that effective measures must be taken to meet the competition from Europe that is likely to develop after the war. At present the Venezuelans are relying largely upon the United States for supplies. Although construction work is not being carried forward with special energy at present the field is worth the closest attention. The report contains information concerning the general industrial and commercial conditions in Venezuela markets for all lines of construction materials and machinery, and the commercial practices and requirements of the country, &c.

MISCELLANEOUS.

"Birmingham Chamber of Commerce Year Book."—We have received from Messrs. Pemrose & Sons, of Derby, a copy of the 1917 (the sixth) edition of the Year Book.

The book consists of [illegible] 500 pages, and contains a classified list of members of the [illegible], statistics of imports and exports, production of minerals, shipping, agriculture, railways, tramways, joint stock companies, [illegible], tables of weights, measures, and foreign moneys, [illegible] of Colonial customs requirements, the industries of Birmingham and the surrounding districts, &c. A new feature, and one which [illegible] by other Chambers of Commerce, [illegible] of British firms, in English, French, Russian and [illegible].

Contract Retention Money. Most of the public authorities have already accepted or acquiesced in the model conditions of the Institution of Electrical Engineers in regard to payments for electrical machinery, and at last week's meeting the London County Council amended their Standing Order No. 295 so as to adopt the model payments clause of the Institution.

In future contracts for machinery [illegible] which has to be erected under [illegible] the terms will be 80 per cent. of the contract value [illegible] delivered or work executed on the site, 10 per cent. [illegible] after the plant is taken over and 10 per cent. after [illegible] 12 months, provided that (1) Should [illegible] defects [illegible] not affect the commercial use of the plant [illegible] retention money shall be retained [illegible] (2) If the contractor [illegible] the purchaser [illegible] 80 per cent. of the value of such plant [illegible] ready for delivery [illegible] half of the retention [illegible] expiration of [illegible] such payment [illegible]

Magnetos for Aeroplanes. [illegible]

Prohibited and Restricted Exports. [illegible]

Workers' War Bonuses. [illegible] heavy burden they impose.

EDUCATIONAL.

University of Liverpool.—A legacy of £10,000 has been left to this University by Mrs. A. C. Chaddock in order to endow a Chair of Commerce.

Sunderland Technical College.—The salary of the principal (Mr. V. A. Mundella) has been increased [illegible] per annum, and the heads of departments have each been granted an increase of £25 per annum.

Pensions for Teachers.—The President of the Board of Education recently received a deputation [illegible] Association, the Headmistresses' Association, the Association of Technical Institutions, the Association of Teachers in Technical Institutes and other educational organisations) on the subject of pensions for teachers.

In reply, Dr. Fisher said, while unable to give a definite undertaking regarding legislation in the near future, he hoped to be able to lay proposals before Parliament for establishing [illegible] secondary and technical teachers.

TENDERS INVITED AND ACCEPTED.

Turbo-Alternator with Condensing Plant.

The Electricity Committee of BOLTON Corporation invite tenders for the supply, delivery and erection of a 7,500 kw. Turbo-alternator, with condensing plant. Specification and form of tender from Mr. W. J. H. Wood, borough electrical engineer, Back o' the Bank, Bolton. Tenders to Town Clerk, Town Hall, Bolton, by noon Jan. 15.

Battery, &c.

TIPPERARY Guardians require tenders by 2 p.m., Jan. [illegible] for the supply of a new Battery in connection with their electric lighting plant and for overhauling a gas engine. Specifications from Mr. [illegible] Tierney, 44, Kildare-street, Dublin.

Telephone Service.

ROSARIO (Argentina) Municipality recently invited tenders, which are to be opened on Feb. 23, for the provision of a telephone service within the district of the municipality.

GLASGOW. The Tramways Committee have accepted the following tenders:

H. Bessemer & Co., 250 steel tyres; Brown Bayley's Steelworks (Ltd.), 500 steel tyres; Carron & Co., chilled iron brake blocks.

Commonwealth Contracts.—The following tenders have been accepted by the Australian Government Departments:

[illegible] £19 [illegible]

APPOINTMENTS VACANT

[illegible] establishment on the south coast.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

ADELAIDE ELECTRIC SUPPLY CO. LTD.)—Mr. R. P. Sellon, who presided over the recent extraordinary general meeting, said that, as last year, owing to delays of the mails, they were not able before the end of the year to issue the audited accounts and hold the annual general meeting. The directors had assured themselves that the year's results warranted the declaration of the usual final dividend upon the ordinary shares. The accounts had now come to hand, and it was anticipated that they would be able to hold the annual meeting early next year. A final dividend was declared on the ordinary shares of 7 per cent., free of British income-tax, making 12 per cent. for the year.

BARBADOS ELECTRIC SUPPLY CORPN. (LTD.)—The profit for the year ended June 30 last was £2.970, against £2,693 for 1916. The number of consumers increased from 1,222 to 1,403, and the 25 c.p. equivalent connections from 17,489 to 19,562. During the year £1,191 was spent on house connections and additions to mains, and a sum of £495 was spent out of profits on repairs, &c.

CONSOLIDATED SIGNAL CO. (LTD.)—The chairman (Mr. S. P. Wood) stated at the meeting last week that the board were glad to be able to realise the hope expressed at the last meeting that the dividend would be doubled on the present occasion, and had it not been for the necessity of making ample provision against various contingencies, and against the uncertainty of the future, they would have increased the distribution. They had now settled down to a steady round of munitions work at each of the home factories, and their improved position had been brought about by the acquisition of additional machinery and plant and increased efficiency in manufacture and methods. The net profits of the subsidiary companies was £38,821—a substantial improvement on the two previous years. In view of the greater wear and tear of the plant, further reserves for depreciation were made. The subsidiary companies distributed £17,702 in dividends and carried forward £9,922. Out of the dividends distributed by those companies their company received £15,912, and after paying expenses and including £6,353 brought forward, £22,854 was available for distribution. It was recommended that the balance of the preference dividend be paid and a dividend on the ordinary shares of 5 per cent. for the year, £7,570 being carried forward. Substantial progress had already been made in the reorganisation scheme foreshadowed last year, and they believed that in due time they would have built up the factories and business into such a state of efficiency that, instead of being, as in the past, practically dependent upon one class of work, the company would be in a position to produce and to obtain work of the highest type, in addition to their standard business. In the first quarter of the current year, to Sept. 30, the orders received were approximately 90 per cent. higher than in the corresponding period last year, and the sales were 30 per cent. higher, which, so far as it went, was satisfactory. But even supposing that these proportions were maintained, he was not enamoured of the outlook in one or two respects, [illegible] labour difficulties and more onerous Governmental [illegible] to labour and the opposite to those who provided the administrative brains and capital.

DELAGOA BAY DEVELOPMENT CORPN. (LTD.).—Mr. H. K. Heyland presided over the meeting last week and said that £6,884 had been expended on the power station plant. The large increase in demand for water and electric light and power and the increase in the number of passengers carried by the electric tramways were due to the fact that [illegible] Portugal declared [illegible]

FRASER & CHALMERS LTD.)—[illegible]

The merchandise business in South Africa had been excellent notwithstanding freight difficulties. Their trading in Australia and Canada and at other branches had been restricted. They had established an office at Petrograd, and their manager (Mr. Catlin), who had been building connections for future trade, had secured several orders for turbines, &c. Mr. Catlin had been asked to come over to this country to confer with the directors, and he had now undertaken a visit to the United States. So far as the immediate future was concerned they were dependent largely upon their ability to obtain supplies of raw material and to maintain a proper labour force. A great deal of the labour unrest throughout the country was due to the want of a properly defined policy on the part of the Government on certain matters which are regarded as essential. He could not understand the reason for the delay in instituting the committees of employers and employed in the various essential industries as recommended by the Whitley report, as this would overcome a considerable amount of the present difficulties and misunderstandings. The report and accounts were adopted, and a dividend of 5 per cent. declared on the ordinary shares.

J. G. & G. HARRIS (LTD.)—The net profit for the year ended June 30 last amounts to £529, which, added to amount brought into account, amounts to £572. After paying income tax (£90), preference dividend (£283) and directors' fees, the balance is £124, which has been carried forward.

PARAGUAY CENTRAL RAILWAY CO. (LTD.)—In the report for the year ended June 30 last it is stated that although the receipts of the Asuncion Tramway Light and Power Co. showed some improvement during the first few months of the year before the Exchange Office suspended sales of gold, the subsequent increase in the commercial rate of exchange, without any corresponding increase in the official rate fixed by the Government (on which the company by its concession has to base its tariffs) again adversely affected the earnings. The re-opening of the conversion office for the sale of gold should improve the position. The business was also adversely affected during the year by a series of strikes extending over a long period.

PROVINCIAL TRAMWAYS CO.—Mr. A. Beattie, who presided over the meeting last week, said that the past year was certainly the best that they had had so far as traffic receipts were concerned, for it showed an increase of £951 over the previous year. The net profit, however, was not quite so great owing to increases in the maintenance of rolling stock, coal and oil, wages, maintenance of electrical equipment, &c. At Plymouth they had a decrease of £3,134 in receipts and an increase of £1,016 in rates. The excess profits duty for 1915 was £5,275 8s. and for 1916 £13,641, making a total of £18,926 8s., and, if they added the increase of £6,296, already referred to, the total was £25,222. The past year had been a very difficult time for tramways and especially in the provincial towns. Any material wanted, however small, required a permit from the Ministry of Munitions to secure it, and they much appreiated what had been done by all their managers. The report was adopted and a final dividend was paid on the ordinary shares of 10d., plus a bonus of 6d. (1s. 4d.), less tax.

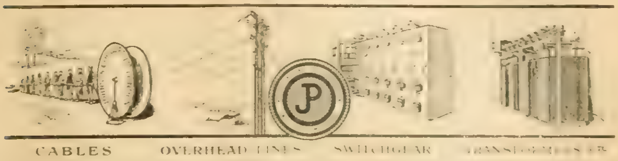
ROSS ELECTRIC LIGHT & POWER CO.—The gross revenue for 1916 was £1,185. 0s. 5d., against £1,315. 7s. 10d. for the previous year; and the expenditure was £1,143. 15s. 2d., against £1,026. 4s. 8d., leaving a balance of £41. 5s. 3d. After deducting the loss of £56. 15s. 8d., brought forward from 1915, and allowing for £282. 3s. 1d. interest due on temporary loans, the net loss is £297. 13s. 6d. The quantity of electricity sold for lighting has fallen considerably (15 per cent.); but, to meet this to some extent, the works have managed to reduce the proportion of units generated to units sold. During the year, an application was made to the Board of Trade for a revision of the maximum charges for current, and, there being no valid objection made, the maximum charges were raised from 7d. per unit and, for any quantity up to 20 units per quarter, 11s. 8d. respectively, to 8d. per unit and 13s. 4d. per quarter. The late resident engineer (Mr. C. E. Gray) having left to join the Navy, arrangements were made that the manager should reside at Ross until such time as a suitable resident engineer could be found. Five new consumers were obtained during the year, in addition to extensions to 11 existing consumers, a total increase of 117 lamps connected. There were 155 consumers (142 lighting and 13 power), having together a total equivalent of [illegible] 30 watt lamps connected.

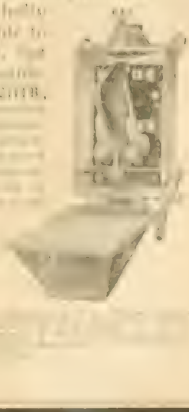
CITY NOTES.

COSTA RICA ELECTRIC LIGHT & TRACTION CO. LTD.—The net earnings [illegible] for year ended June 30, after charging all expenses [illegible] were $11,381, compared with $19,211 for the previous year [illegible] the year of $8,827, caused principally by the serious [illegible] of the Costa Rica currency.

MARCONI INTERNATIONAL MARINE COMMUNICATION CO. (LTD.)—The directors have declared an interim dividend of 5 per cent. (1s. per share), less tax, on account of the current year. Warrants will be posted [illegible]

RICHARDSON, WESTGARTH & CO. (LTD).—Meetings of the preference and ordinary shareholders were held last week in order to consider a scheme of reconstruction, but the proposals were defeated and a committee of shareholders will confer with the directors in order to formulate [illegible]


CABLES
OVERHEAD LINES
SWITCHGEAR



THE ROUND TABLE.

By "kVA."

EVENT OF THE WEEK. The 16-Super-Stations-per-Great Britain-Electric Power Scheme! (What's Ireland done?)

* * * *

How many "Round Table" readers had electrically-roasted turkey this Christmas?

* * * *

Congratulations to "Hackney" Robinson upon the result of the preference appeal case. The Gas Light and Coke Co. will now perhaps stick to T.N.T.

* * * *

When one comes to think of it there is a lot of satisfaction to be derived from the fact that not even a war can extract anything from electricity supply. While gas must be depleted for explosives for the Hun (curtailing explosions at home, I hope), electric pressure, which not even the M.O.M. may tamper with, is steadily maintained.

* * * *

R. P. Hearne lets himself go in a recent issue of the "Evening Standard," under the heading of "Electrified Clothing." After describing the methods whereby airmen keep warm by electrically heated suits, the writer allows his imagination full play, for I presume he had a column to fill on the subject and must needs fill it. Beer is still 10d. per pint in Fleet-street. Here is one of his "spasms":—

Even the average citizen will have uses for the heated clothing. A traveller, for instance, with a suitably wired overcoat could connect his circuit with an electric lamp socket in a railway station waiting-room, and thus keep himself warm; or failing this supply of current, he would carry his own battery. Unheated railway carriages would lose their terror for the electrified traveller.

The country dweller on his travels would have an electric battery sufficient to light a flash lamp as well as keep him warm, and during the lighting restriction period even the suburban traveller might usefully have his electric clothing adapted so as to faintly illuminate his presence. "Heated him in glow worms" may thus come to be an accurate description of many people.

I must send Mr. Hearne a book on the watt hours per lb. obtainable from storage batteries and the umteen different voltages and systems of electricity supply on one only of our main line railways.

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN, December 2?, 1880.]

ROTARY ENGINES.—Messrs. [illegible] have been testing at their Works, [illegible] rotary engines for driving electric light apparatus, and the results have been [illegible].

THE WEST COAST OF AMERICA [illegible] COMPANY.—The Board of the Company state that [illegible] of the continuance of the war between Chili and Peru they [illegible] to defer payment of the coupons on the debentures of the Company due on Dec. 31 next.

THE [illegible] LIGHT.—The [illegible] of the clock tower of the Houses of Parliament [illegible] Charing Cross [illegible] lately lighted by the Brush electric light, and the contrast with the face looking towards [illegible] very striking. The [illegible] appearance, while [illegible] [illegible] and [illegible] gas burners [illegible].

Belfast Strike.—A hundred semi-skilled and unskilled employees engaged in connection with the boiler house and coal-handling machinery of the electricity department went out on strike on the 21st inst.

The strike, which was [illegible] without the sanction of the men's union, [illegible] Corporation had not [illegible] of 12½ per cent. The [illegible] work in sympathy with the strikers, [illegible] serious difficulty. The city electrical engineer (Mr. T. W. Bloxam) and the [illegible] occasion, and a supply of current [illegible] available.

The men have now agreed to restart work [illegible] of the Minister of Munitions.

Customs Decisions.—According to recent decisions, the import duty upon electric motor tyre pumps and electric magnets (parts of crane) imported into the Union of South Africa, the whole duty being allowed as rebate upon British goods.

Corea.—Mr. P. D. Butler (British Acting Vice-Consul at Seoul), writing on the prospects of the port of Chinnampo and the north-western part of Corea, gives the following information:—

The Government General's anthracite coal mines at [illegible] have an electric power station of 400 kw. capacity, and this is now to be increased to 2,250 kw. The present dynamos were made by a Japanese firm.

At Kenji-ho (near the mouth of the river Daido-ko, an iron foundry and steel mills are under construction for a Japanese firm. The foundry is to cost £1,200,000, and the steel mills between £1,200,000 and £1,800,000. The furnaces will be fed with ore from the company's own [illegible] in Corea.

The total trade of the port of Chinnampo rose from £302,532 in the first half of 1915 to £796,645 in the first half of 1917.

Siam.—Imports through the port of Bangkok included electrical goods and apparatus valued at £32,580 in 1915-16, and £65,769 in 1916-17, and manufactures of metals £310,244 in 1915-16, and £340,714 in 1916-17.

Electrical Engineering in Germany.—The report of the A.E.G., of Berlin, states that the number of hands employed at the end of the financial year 1916-17 was 79,293.

The gross profits increased by 7,040,000 marks to 40,793,247 marks. War and expenses were 10,140,217 marks. A sum of 2,000,000 marks was devoted to gratuities, a like sum to the pension fund, and 1,500,000 marks to war welfare work. The turbine factory is engaged in making units of 50,000 kw., and the machine shop [illegible] the largest transformers so far built (of 60,000 k.v.a. and 110,000 volts), cannot keep up with the demand for high-voltage material. In the wireless telegraph department important new developments have been made. The deliveries of electrical apparatus exceed those of the previous year, and in the incandescent lamp branch the selling prices have been more commensurate with the cost of manufacture. The company is engaged on armour-plate work. The [illegible] at Frankfort will be amalgamated with the Berlin works, and the National Automobile Company is working satisfactorily. The demand for electrical machinery for war factories, especially in the chemical industry, is active. Satisfactory orders [illegible] industries. The [illegible] power station [illegible] capacity, and the power station [illegible] at Bitterfeld, have been completed. The power station of the Fortuna mine has been enlarged [illegible] [illegible]

EYE-REST LIGHTING INSTALLATION.

The Crown Agents for the Colonies have erected a handsome set of buildings facing the Embankment, Westminster. Part of these buildings was completed before the war, and the lighting arrangements, therefore, were very carefully considered before the equipment was selected. To this end an extensive series of tests, running over six months, were made on all forms of lighting systems—

EXAMPLE OF OFFICE LIGHTING ON THE B.T.-H. "EYE-REST" INDIRECT SYSTEM.

direct, semi-indirect and indirect—with numerous types of equipment. As a result of these tests indirect lighting with half-watt type lamps was selected and a trial equipment of the well-known B.T.-H. "Eye-Rest" system was installed.

A thorough trial was made under practical conditions of office work and criticisms and comments were taken from the various employees as to the results from this lighting system. The opinions expressed were unanimously in favour of the "Eye-Rest" system of indirect lighting, and this type of equipment was specified and ordered for the lighting of the entire building. When the additional buildings of the

EXAMPLE OF OFFICE LIGHTING ON THE B.T.-H. "EYE-REST" INDIRECT SYSTEM.

[illegible] belonging to the department were completed, a year or so later, the "Eye-Rest" indirect lighting system with half-watt type lamps was installed throughout, so that the complete set of buildings is entirely equipped with this system of lighting. We are able to present our readers with some interesting views of some of the rooms at the Crown Agents for the Colonies buildings, showing the "Eye-Rest" equipment and the lighting results given. The illustrations are reproduced from untouched photographs taken by the actual light of the fittings installed. Messrs. John W. Simpson and Flight-Lieut. Maxwell Ayrton, R.N., Verulam Buildings, Gray's Inn, W.C., were the architects, and Messrs. A. G. [illegible] & Co., Broadway Chambers, Westminster, the contractors for the lighting arrangement.

CONNECTIONS TO ELECTRIC SUPPLY MAINS.

In a communication to electric supply authorities (dated Dec. 8, 1917) the director of electric power supply (Mr. Arnold B. Gridley) stated that until further notice the Ministry of Munitions would

raise no objection to additional connections being made subject to the following conditions:—

1. That they had adequate generating plant capacity available. 2. That no lead covered cable was used on the connection. 3. That the cost of the connection (including any mains extensions) to be borne either by your undertaking or by the consumer did not exceed £10; and that at the end of each month a list of consumers connected during the month, giving name, address, purpose (*e.g.*, private house, ironmonger's shop, or paint manufacturer) kilowatts installed, and cost of connection, was supplied to the Director.

Mr. Gridley added that it was not desirable to connect new consumers who already had alternative methods of obtaining light, heat or power, or business premises not used for direct or indirect war work. No connection, the cost of which would exceed £10, or in which lead-covered cable was required, might be made until the sanction of the Department had been obtained.

On Dec. 13 the hon. secretary of the I.M.E.A. (Mr. H. Faraday Proctor, of Bristol) inquired whether lead-covered cable already in the stock of the respective undertakings might be used without a special permit. In his communication Mr. Faraday Proctor wrote: It appears to me that in the interests of economy it were well that any manufactured article should be put into use at the earliest possible date, provided always that the purpose for which it is used is at least as necessary or desirable for the general welfare of the country, as the purpose for which it would ultimately be used if it were held in stock until after the war, or otherwise the period when restrictions are withdrawn. I assume—and would like your opinion as to whether I am right in assuming—that lead-covered cable already manufactured will not be pulled to pieces for the purpose of recovering the lead. If such assumption is correct and my reasoning holds good, then it only remains to say what class, of consumer cable already manufactured and in stock may be used for. I have considered the question as to whether a return of stocks should be obtained with a view to such being utilised in districts where the demand for extensions is most imperative, but it appears to me that in such districts cables other than lead-covered may be laid down as a temporary expedient, even though they must be taken up in the course of a few years to be replaced by lead-covered cables, which to-day must be recognised as being the only satisfactory cables for underground work. It were fairer, however, that the undertakings who have to give supplies under these exceptional conditions should bear the whole of the exceptional costs of putting in temporary cables or otherwise, and recover the same from the special consumers, rather than that the matter be further complicated by the collection of odd lengths of cables from various districts."

In reply, Mr. Gridley wrote on the 14th inst.: "It is desirable that existing stocks of lead-covered cable should be husbanded as carefully as possible. Lead-covered cable should not, therefore, be used for making house connections, except in accordance with the conditions set out in my circular letter of the 8th inst. I should hope circumstances will not arise to necessitate any so drastic a move as the scrapping of new cable for the purpose of recovering the lead. At the moment it is not proposed to get in a return of existing stocks of lead-covered cable."

On Dec. 12 Mr. Howie asked for the following information:—

(*a*) Where the cost of the connection exceeds £10, does the stipulation that it must not be made until the sanction of your Department has been obtained apply to direct war work accompanied by a certificate?

(*b*) Where the connection costs less than £10, and which may be made without the sanction of your Department, what certificate or reference may I give to the cable manufacturers, &c., in obtaining the necessary material?

(*c*) As the subject matter of your letter is of considerable importance to this undertaking, I shall be much obliged if you will inform me, for the guidance of my Committee, under what regulation your instructions are given.

In reply, Mr. Gridley stated that "no connection the cost of which exceeds £10 should be made without the sanction of this Department. A certificate for any expenditure which is to be borne by your department must be applied for, and be granted to you direct. No new cable can be purchased without a permit, and when it is necessary to order additional cable an application should be made stating the length, type, and [illegible] of the cable required. The instructions given you are under the [illegible] of the Ministry of Munitions affecting the control of copper, [illegible] and other [illegible] material."

ELECTRIC POWER DEVELOPMENT IN QUEBEC.

[illegible] demand for electric power in the Quebec province appears [illegible] rapid rate owing to the industrial development [illegible] upon the war. New industries have been established [illegible] the Shawinigan Water & Power Co., because of the [illegible] character of the supply and of the gradual [illegible] of the economy of electric power.

The [illegible] Co. anticipates that during the current year over [illegible] motors will be connected, [illegible],000 h.p. of the [illegible] Shawinigan Falls. This [illegible] to be in addition [illegible] new load. The increased output of the [illegible] 30 per cent. above that of 1916. The industries con[illegible] are, however, important factors in the increased [illegible]. The Carbide Co.'s output is 50 per cent. [illegible] in 1916, while the electrode plant cannot meet

the demands upon it. The Aluminium Co. is taking 40,000 H.P.; t Canadian Aloxite Co., which is building an extensive plant at Shawinigan Falls, will also take a large block of power, and the Public Service Corporation, of Quebec, have increased their business 25 per cent. over 1916.

The "Electrical News" of Canada reports that as a result of the situation the resources of the Shawinigan system are being used up as fast as they can be developed. The Laurentide Power Co.'s output will be increased next year about 50 per cent. by the completion of the dam at the head of the St. Maurice River. Surveys have been started at the Gres Falls power site with a view to development at a comparatively early date. The Shawinigan Co. are also building an aerial span 5,000 ft. long, supported by towers 350 ft. high, across the St. Lawrence at Three Rivers. It is claimed by the company that power is being used up faster in the district than in any district in America. Other power companies in the province are also extending their operations. The Montreal Tramways have added a 17,000 H.P. steam unit to their plant, and have commenced work on another unit of the same size. The Southern Canada Power Co. have mapped out an ambitious programme and are carrying out extensions of plant and of their transmission lines in one of the most promising industrial districts of the province. The Cedars Rapids Manufacturing & Power Co. are adding to their powerhouse and installing new units, owing to the continued requests for power. The August earnings of the Civic Investments & Industrial Co. which operates the Cedars Rapids plant and the Montreal Light, Heat and Power Co., were $783,412, compared with an average of $754,000 for the nine months, August, 1916, to April 30, 1917. At Sherbrooke, where the demand for power exceeded the supply, the city has purchased an additional water-power, and are planning to build a transmission line and to instal further equipment.

U.S.A. CONTRACTORS' ORGANISATION.

At the recent annual Convention of the National Electrical Contractors' Association a new constitution was discussed and adopted, while a scheme for the sale of electrical supplies and fittings was also agreed to. The general outline of the latter scheme, which was referred to as the Goodwin plan of merchandising electrical goods, is as follows:—

The inauguration of a campaign of education, which has already been inaugurated and will be conducted principally through trade papers, trade organisations and other channels, in order to co-ordinate the various interests in the electrical industry. The plan seeks to bring together in harmonious action the various interests in the industry, so that there may be established the retail distribution of electrical materials, at fair prices to the consumer and with a fair profit to all parties taking part in the transaction.

The plan assumes that each individual owes a responsibility to the organisation representing his branch of the industry, and that the organisation owes a similar responsibility to its members; that each organisation representing each branch of the industry owes a responsibility to all other organisations in the industry, to the end that all problems may be discussed having in view the interest of all—thus providing a [illegible] plan for more adequately and efficiently serving the American public and resulting in an extension of the activities of the industry to the great undeveloped field before us. In outlining his plan Mr. Goodwin expressed the belief that it will be necessary for the National Contractors' Organisation to have an income of at least $250,000 per year to deal properly with the problem before the contractor-dealer.

According to the report in the "Electrical World" local associations form the working unit, governed by State and national associations and boards by delegates from the local. The constitution also provides for membership such as drug stores, hardware and department stores which are doing a retail electrical business.

It is obvious from the above that American contractors and dealers intend to place their organisation on a sound basis, and that they propose to develop their trade relations with the other branch of the electrical industry. The result should make for greater electrical progress in future and there would be smoother relations between the supply companies and the dealers and factors of electrical goods and supplies.

AUTOMATIC TRUCK LOADER.

In the United States close attention is paid to economy in the handling of materials, and consequently instances of the adoption of automatic devices are common. For instance, the American Optical Co., of Southbridge (Mass.), being confronted with the problem of loading coal from its ground storage pile by other means than hand shovellers, found a solution by utilising a Link-Belt wagon and truck loader.

This machine loads the material at the rate of 1 ton per minute, and requires but one man for operating, thereby cutting down the operating costs. As the coal storage pile was some distance from the power house it was necessary to transport the coal to the boilers. The bituminous coal is received by the carload, and is dumped from the trestle to the ground storage pile. It is then loaded into trucks by the Link Belt loader for transportation to the power house, where it is again transferred and fed to the automatic boiler stokers. The automatic loader is operated by an electric motor and loads the truck in about five minutes. With the use of this machine the costs of handling coal and gravel have been reduced over 50 per cent., and the same machine is also used in the sand bank, with good results. It enables the company to handle in one day as much as was formerly handled in two days. The loader has loaded 80 cubic yds. of earth, which was carried a half mile by a 2-ton truck in one day.

SIGNALLING PROGRESS IN U.S.A.

The "Railway Gazette" states that the number of block sections on Jan. 1, 1917, was 57,228, compared with 54,171 in 1916. The use of the electric motor signal is being greatly extended, as during the year the route mileage protected therewith was increased from 27,716 to 29,588.

At the beginning of 1916 there were 34 systems in the United States using the electric train staff on 383 miles, but in January last 36 companies used it on 417·9 miles. Permissive signalling was forbidden entirely on 4,784 route-miles out of the 65,453·3, compared with 4,140 miles at the beginning of 1916. Alternating current was on Jan. 1, 1917, used on 3,336·2 miles out of the 98,407·9 miles for track circuits, against 3,186 miles, and on 3,027·2 miles for operating the signals, against 2,779 miles. Three-position signals were on 15,535·7 miles, compared with 13,712 miles, and the upper quadrant working on 16,069·7 miles as against 14,429 miles. Of signals that were lighted electrically there were 5,168·3 route-miles in January, 1917, compared with 4,491 miles in 1916. Of the total mileage of 247,967 reporting to the Commission, 149,456 miles used the telegraph for train order dispatching and 103,393 the telephone. The use of the latter as a substitute for the former is increasing.

Electricity and Gas Supply in Italy.—A new Government decree limits the use of electric lighting, prohibits the use of electricity for heating between 4 p.m. and 10 p.m. and forbids the further sale of electric heating apparatus. Gas supply is already shut off the greater part of the day, and will, it is stated, shortly be cut off altogether for heating purposes.

// THE ELECTRICIAN:

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CONTENTS.

Notes.

Patents Expiring in 1918.

FROM the list [illegible] on another page it will be seen that quite a number of interesting patents granted in 1904 will expire during the present year. Taking them in the order of date, we may mention No. 1,368 [illegible] the well known Moscicki condenser in which those parts of the dielectric near the edges of the coating are made considerably thicker than the remainder [illegible]. The [illegible]. In patent No. 2,273 Sir Robert Hadfield describes a [illegible] of high permeability and high resistance [illegible] under the trade name of "Stalloy." [illegible] ferably containing neon, as an indicator in combination with this [illegible] No. 27,683, in which the movement of the handle not only alters [illegible] both the self-induction and the capacity in the same proportion. Patent No. [illegible] depends upon the combination of two magnetic fields and two [illegible]. In patent No. 18,403 Mr. C. P. Townsend describes his [illegible] electrolytic cell. This cell consists essentially of a centre compartment with two lateral compartments, one on either side, these compartments being separated by porous diaphragms of asbestos paper. The centre compartment contains [illegible] graphite. The cathodes are fixed in the lateral compartments and are composed of a pervious material, such as [illegible] mesh, and are fixed against the porous diaphragms. A stream of sodium chloride solution flows through the centre compartment, where the electrolysis causes chlorine to be given off, which is removed in some convenient way. The lateral compartments are filled with a liquid which will not mix with the solution under electrolysis, [illegible] fying oil. The electrolyte percolates through the diaphragm to the anodes, where caustic soda is formed; this gravitates to the bottom of the cell, taking up a position below the oil, and it can therefore be easily removed. In patent No. 28,154 Mr. H. Kuzel describes the use of colloidal metals for the formation of metal filaments for lamps. [illegible] without any binding material, and is squirted through a die [illegible] heated to 60°-80°C. they become conducting, but they lose their conductivity again on cooling. The required conductivity is secured by heating to a white heat, preferably by passing a current through them [illegible] 60°C. to 80°C. The Hoskins base metal couples are described [illegible] from metals having a very high melting point alloyed with nickel, and form couples having a comparatively high E.M.F. in conjunction with nickel-copper elements. Lastly, in patent No. [illegible] paste, which is cooked *in situ* in the container after it has assumed the solid porous state.

Applications for Provisional Orders and Bills.

IT appears that there will be greater activity during the 1918 session of Parliament in the promotion of electric light and [illegible] Dronfield Woodhouse. From the petitions for private Bills we notice that the Shropshire, Worcestershire & Staffordshire [illegible] will be the largest of its kind in England. The Gloucestershire [illegible]

Parliament. During the last three years the importance of generating electric power on a large scale has become so manifest that it is possible the subject may even appeal to a Parliamentary Committee, and that the members may realise that there is a great deal to be said in favour of the large power station when it comes to a question of saving fuel, for the reason that generation is carried on under more economical conditions, and a higher diversity factor is obtained.

British Museum. The buildings of the British Museum have been requisitioned by the Air Board. Sir Arthur Evans, F.R.S. (President of the British Association and a trustee of the Museum), has written a letter to the Press protesting against the step.

"Production." The December issue of "Production," the journal of the British Empire Producers' Organisation, touches upon a number of interesting topics. Some of the articles refer to important questions of finance raised by the war and the suggestion for an Imperial Bank of Industry. The latter is the subject of a report by a committee of the B.E.P.O. An interesting article on "Triumphs of British Engineering" is contributed by Mr. A. G. White.

Institution of Civil Engineers.—On January 2nd the Institution of Civil Engineers completed the hundredth year of its existence, having been established in 1818 at a meeting of eight engineers at the Kendal Coffee House in Fleet street. At the next ordinary meeting of the Institution on January 8th, before the discussion of Papers, a statement commemorative of the founding of the Institution on January 2, 1818, will be made, present conditions precluding more formal celebration of the centenary.

Control of Lighting.—By an Order (dated Dec. 24) the Ministry of Munitions has obtained extensive powers with regard to the control of lighting:—

The Ministry may, with a view to maintaining or increasing the supply of light, heat, or power for the purpose of the production, repair, or transport of war material or any other work necessary for the successful prosecution of the war, by order direct that lights of any specified class or description shall be extinguished or their use restricted to such extent, between such hours, within such areas, on such premises and during such period as may be specified in the order, and if any person having control [illegible] in connection with which [illegible] acts in contravention of any such order he shall be guilty of a summary offence against these regulations.

Restriction of Display Lighting in New York.—By order of the Fuel Administrator the use of electric display lighting in American cities is being limited, and such devices are now only to be used between the hours of 7.45 p.m. and 11 p.m. [illegible]

A New Process of Colour Photography. [illegible] are thus formed, which may be as fine as one thirtieth of a millimetre. The other side of the film may be similarly treated with the other colours. Three double pairs of colours, (1) yellow and blue, red and green, (2) yellow and red, blue and orange, (3) red and blue, yellow and violet, are suggested.

New Year's Honours.—Probably there has never been issued a list of New Year's Honours in which there were fewer names of engineers and scientific men than in that which was issued on Tuesday last. With the exception of the medical profession we have failed to discover the name of any prominent scientific men in the list. The following, however, are directly or indirectly connected with electrical engineering:—

Privy Councillor.—Major Sir Henry Norman, Bart., M.P., who has done important war work, and is interested in wireless telegraphy.

Baronet.—Sir Joseph Lawrence, chairman of Linotype & Machinery (Ltd.).

Knights.—Mr. James Bird, clerk of the London County Council since 1915.

Prof. W. H. Hadow, M.A., Principal of Armstrong College, Newcastle-on-Tyne.

W. L. Atkinson, LL.D., mining engineer and inspector of coal mines.

Mr. E. B. Phipps, C.B., principal assistant secretary of the Elementary Education Branch of the Board of Education.

Mr. Thos. Putman, managing director of the Darlington Forge Co.

C.B.—Mr. A. H. Norway, assistant secretary of the General Post Office.

Iron Pipes for 'Bus-Bars.—An interesting sign of the times, reported in the "Electrical World," is the use by an American central station of iron pipe for 'bus-bars. The Central Illinois Public Services Co. has been using 0·5-in. iron pipe for its indoor 33,000-volt station for 'bus-bars and drops to transformers and oil-switches. Copper tubing of the same size was formerly used, but in view of the rise in the price of copper tube to 50 cents a foot, iron pipe, costing only 5·75 cents a foot, has been substituted. While the iron pipe cannot be bent so easily into the desired shape as can copper tube of similar diameter, it will answer in this respect if care be taken. The chief difficulty met with is that the iron pipe tends to break at the seams. To make a more finished job and permit the surface to be more easily cleaned, the iron tubes are painted with a bronze paint. At present iron piping has only been used in sub-stations of comparatively small size, the largest station so treated being one with three 2,000-kw. transformers connected in delta. In this station iron pipe has been used on the 33,000-volt side of the transformers with complete success.

The Junkers Double-Piston Engine.—A recent number of the "Journal" of the Society of Automobile Engineers (New York) contains a very interesting contribution by Mr. Phillip L. Scott on the Junkers double-piston engine, developed by Prof. Junkers, of Aachen, and which appears to have had remarkable success in Germany since the outbreak of war. The control of the violent energy transformation, occurring in a very small space, in the Diesel engine has long presented difficulties. It was attacked by Prof. Junkers in 1892, the problem, it is stated, being largely solved by the introduction of the double-piston arrangement about 1908. In the Junkers engine a two-stroke constant-pressure cycle is used, and two pistons, moving in opposite directions, operate in the same cylinder. The indicator card diagram approaches closely to the theoretical without the drop in the admission line characteristic of Diesel engines in general. The first severe trials on a commercial basis were made with an 800-H.P. engine on the ship "Primus," but since 1911 the A.E.G. and the Hamburg-Amerika line have combined in building Junkers-engined vessels of large tonnage, an island in the Elbe having been purchased for the yards and factory. Direct-coupled dynamos using these engines are installed on some German cruisers and aeroplane and tractor engines have likewise been developed. Its development in Germany has been favoured by the necessity to make use of tar oils, owing to scarcity of crude oil distillates. Such oils naturally require a higher initial temperature to start combustion, but it is stated that this difficulty has been overcome, and that the engines will now start cold (16°C.) on tar oil. This would hardly have been possible without the double-piston engine. The original engines from which the later forms have developed, had a speed range of 30

to 300 revs. per min., and an overall mechanical efficiency of 73·5 per cent. The marine engine is direct reversible. The typical 1,000 H.P. stationary engine will run at 25-220 revs. per min. The fuel consumption of the larger engines is equivalent to 0·387 lb. per brake horse power per hour (referred to oil of 18,000 B.Th.U. per lb.). An overload of 50 per cent. is possible, and the double-piston arrangement makes possible perfect balance of moving parts—an important consideration in aeroplane and high-speed automobile engines. The 200 H.P. aeroplane engine is stated to weigh $3\frac{1}{2}$ lb. per horse power.

Report of Coal Conservation Sub-Committee.—We have received communications on this subject from Ald. G. Pearson (chairman Bristol Electrical Committee, hon solicitor to the Incorporated Municipal Electrical Association) and from Mr. H. Faraday Proctor, engineer and general manager, Bristol Corporation electricity department, and hon. secretary to the I.M.E.A.

Ald. Pearson writes as follows:—The Municipal Electrical Association has never opposed a scheme for improving the electrical supply of the country, and bringing [illegible] includes 187 municipalities [illegible] its hon. secretary, Mr. H. Faraday Proctor, [illegible] Government Committee in October, 1916, advocated the appointment of a single Government Department [illegible] the administration of the Electric Lighting Acts and Tramway Acts and the whole of the responsibilities of the various Government departments at present [illegible] Acts. The proposals of the Municipal Electrical Association related to other matters [illegible] the Board of Trade Committee on Electrical Power Supply is now sitting. I regret that the Coal Conservation Committee, on which no representatives of municipal undertakings [illegible] expect to have received from the Board of Trade Committee on which municipalities secured representation after a severe struggle in Parliament. I also regret that a report has been issued favouring company working as against [illegible] at a time when this matter is under the consideration of the Board of Trade Electrical Supply Committee, and particularly that the operations of one company are dealt with, as proving, in some degree, the correctness of the opinions set forth in the report. We have in Bristol endeavoured to secure a cheap and reliable supply of electric current for all purposes. We have never favoured profit being made out of the electric consumer, but only to preserve the financial equilibrium [illegible] on the business. Cheap electricity is, in my opinion, necessary to our true progress. And it is of infinitely greater importance that the district should have a cheap supply than that any profit should be made by the Corporation in connection with this undertaking. Another thing, it is essential to success to be able to obtain cheap money [illegible] municipalities than by companies, and still more easily by the Government. I also [illegible] Municipalities have suffered in the past [illegible] district.

Mr. Faraday Proctor [illegible] general purposes.

Obituary.

[illegible] E. M. Sayers, A.M.Inst.C.E., M.I.E.E., partner in the firm of Messrs. Clark, Forde, Taylor & Erskine Murray.

Mr. Sayers was educated [illegible] Kensington. In 1880 [illegible] 20 years has been [illegible] undertaken. Mr. Sayers [illegible] tion with the laying of the Bermuda-Turk's Island-Jamaica cable in 1898, and in the 19 years following he led a busy life, acting as chief assistant and afterwards in 1910, when he became a partner in the firm, on many cable laying expeditions; amongst them may be mentioned the Pacific cable and the laying of the following cables of the Commercial Companies: Fayal (Azores) and Canso (Nova Scotia), Weston-super-Mare and Waterville (Ireland), New York and Havana, the diversion of the Atlantic cable to St. John's (N.F.), and the extension of St. John's Canso cable to New York, as well as [illegible] expeditions. Mr. Sayers possessed [illegible] was so earnest in all he undertook that he will leave his mark on the calling he had chosen, and for which he was especially fitted by sound knowledge, ability and charm of manner. He contributed Papers on electrical subjects to the technical journals, and amongst them were: "Use of the Electrometer in Cable Testing," "Temperature Coefficient for Loss of Charge of Paraffin Paper Condensers," &c. Quite recently he attacked the difficult problem of computing the depreciation of submarine cables, and his death has deprived us of an important Paper on this subject. His services to the various cable companies for whom he has acted have been recognised in the fullest way, and though he was not one who courted publicity he endeared himself to all who came into contact with him.

DEATHS ON ACTIVE SERVICE.—[illegible] was educated at University College, London, where he graduated B.Sc. with First Class Honours [illegible] Scholarship for applied mathematics, a First Prize for thermo-dynamics, graphics and machine design.

[illegible] Dec. 8, was the younger son of Mr. C. G. Tegetmeier. He joined the staff of the British Electrical Federation in 1913, enlisted on the outbreak of the war, and, choosing to remain in the ranks, served on the different fronts until the time of his death.

Pte. A. E. Haffenden (Lancs. Regt.), formerly in the India Rubber Co.'s general office, was killed on Oct. 22.

Pte. J. Entwistle (King's Liverpool Regt.), formerly a Blackpool Corporation tramway employee, is reported killed.

Pte. N. Whittaker (Welsh Regt.), a Bolton tramcar conductor, is reported killed in action.

Electrical Artificer Wm. Howarth, who was 22 years of age, and lost his life on the occasion of the sinking of the "Stephen Furness," was formerly engaged as an electrician at Manchester.

Personal.

The Newport (Mon.) Council have [illegible] Committee's recommendation that Mr. [illegible] a further increase [illegible]

MILITARY HONOURS.—The following [illegible]

Acting Capt. and Adjt. V. C. Russell (Suffolk Regt.), son of Mr. Stuart A. Russell [illegible] Cross. He has been twice wounded and twice mentioned in despatches.

[illegible] awarded the Military Medal for saving wounded men under fire. He is [illegible]

Flight Sergt. T. H. Ames (R.F.C.) has been promoted Second Lieut. [illegible] Blackburn.

Arrangements for the Week.

SATURDAY, Jan. 5th.

[illegible]

TUESDAY, Jan. 8th.

[illegible]

WEDNESDAY, Jan. 9th.

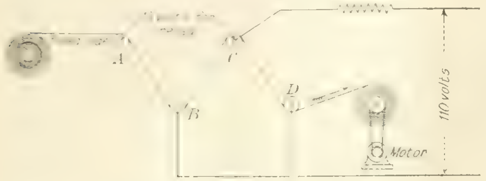
[illegible]

THURSDAY, Jan. 10th.

[illegible]

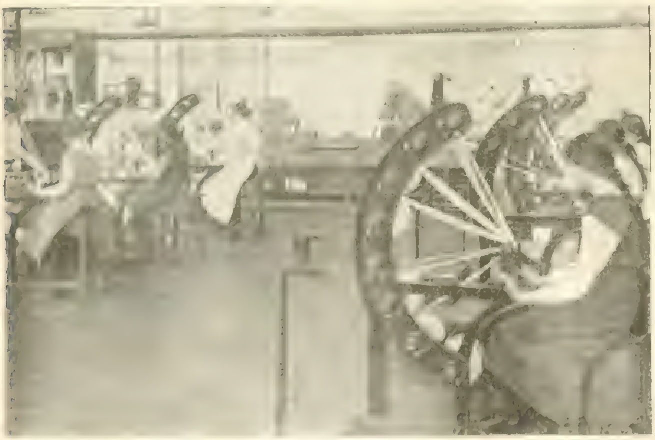
Condensers for Power Circuits.

It was in 1908 that Mr. C. F. Mansbridge described before the Institution of Electrical Engineers his method of making condensers. At that time such condensers were used chiefly for telephone and telegraphic purposes, and although there has always been a certain opening for the use of condensers for low voltage power circuits there was not sufficient inducement at that time to push the matter in this direction to any great extent. Now, however, the evils of low power factor are making themselves increasingly felt as the power load is developed, and consequently the subject of the correction of power factor by means of condensers, as distinct from corrections by means of what are sometimes called rotary condensers and similar plant, has become of greater importance.



[illegible]

[illegible] to refer to what is being done by the British Insulated & Helsby Cables (Ltd.) at their Helsby works in the [illegible] of condensers for power purposes. The fundamental idea of the process is the same as that on which the condensers are made for telephonic purposes. Tin-foiled paper is used as the conductor, and the dielectric in the first instance is paper. The tin-foiled paper is prepared by throwing down tin from its solution either chemically or electrically. After precipitation the powder is repeatedly washed to free it from all traces of acid, and is then [illegible] very fine mesh, so as to eliminate all large particles of tin or grit. A suitable adhesive, such as size, is added, [illegible] applied to one side of the paper mechanically



[illegible]

[illegible]

[illegible]

From this it is seen that the paper passes over four metal rollers, A, B, C, D. Two of these (B and D) are connected in parallel to a 110-volt direct current circuit, the other pole being connected to the intermediate roller C. If there is a defect in the paper a current passes, the effect of this being to blow away the tin in the neighbourhood of the defect, so that it becomes non-conducting at the fault.

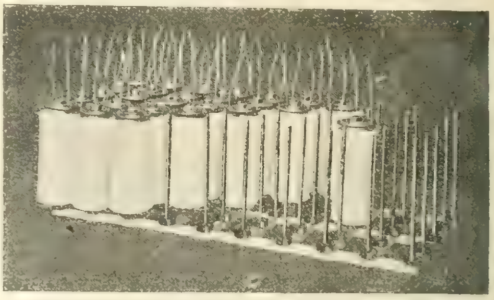


FIG. 3.—CONDENSER UNITS ASSEMBLED.

There is also a pressure of 10 volts across the rollers A C for operating a relay. Normally a current flows through the relay via the tinfoil between the rollers A and C, and maintains the motor circuit, but if there is any break in the continuity of the tinfoil or the conductivity of the foil falls below a predetermined figure, this relay operates and stops the motor.

After the paper has been tested in this way it is dried and can then be used for making up the condensers. In the case of power condensers the thickness of the dielectric must vary with the voltage at which they are to work. In the ordinary type which is used on circuits up to 660 volts three strips of special paper of high dielectric strength are used with each electrode, which consists of one strip of foiled paper. It is also necessary to have the tension of each strip of paper carefully adjusted. Consequently the rolls are mounted on the arc of a circle with the winding spindle at the centre of the arc, as seen in Fig. 2. An indicator shows the operator when sufficient paper has been wound for the required capacity.

After winding, the units are dried for some days at atmospheric pressure, and then in vacuum for some hours. They are then impregnated. In the case of telephone condensers [illegible] used for this purpose, the condenser thus being made solid, but in power condensers the highest grade of non-sludging oil is employed. Impregnation is effected by allowing the oil to pass into the vacuum vessel. Once the oil has been admitted care is taken to keep the unit continuously immersed in oil. They are transferred to a vacuum chamber for about 24 hours, the vacuum being released at intervals to ensure complete impregnation.

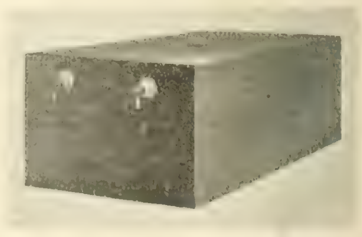


FIG. 4.—COMPLETE CONDENSER OF 50 MFD.

The normal unit has a capacity of 1 mfd., and 50 such units are set up in a box. Fig. 3 shows a number of these units, with their terminal wires, on a frame before impregnation, the frame being the fitting on which they are held in the finished case. A complete condenser is shown in Fig. 4. This consists of a metal hermetically

sealed oil-tight box, containing the frame of units which is secured to the base of the box. The terminals are brought out through oil-tight bushes; these are made up with special rubber washers, which are recessed into the porcelain insulation of the bush, and since the washers swell when the oil reaches them a thoroughly oil-tight joint is obtained.

The normal working pressure for which these units are designed is 600 to 660 volts, and before the lid of the case is sweated on the units are flashed at 2,800 volts. They are, when completely finished, also subjected to a pressure of 750 volts for eight hours.

FIG. 5.—Power [illegible] of 1,200 Mfds.

A high quality non-sludging oil is used, and it is stated that no deterioration of the condensers is found with the lapse of time. The first units of this type that were made have been in continuous service at 550 volts for upwards of three years.

Large condensers are made up by assembling a number of the standard size condenser boxes in a frame, as seen in Fig. 5. A resistance of, say, 5,000 ohms in series with one or more lamps is permanently connected across the terminals of such condensers to [illegible]

FIG. 6.—[illegible]

[illegible]

and applied as near the sources of low power factor as may be convenient. The final criterion, however, is generally the cost per kilovolt-ampere. Here the condenser is in certain cases at a disadvantage in that, assuming a fixed frequency, the capacity required to give a definite output in kilovolt-amperes varies inversely as the square of the voltage. Consequently, if the maximum working voltage of a condenser unit is 660 volts, the cost per kilovolt-ampere will be a minimum for that voltage (or multiples of that voltage), and will increase somewhat rapidly for lower voltages.

The cost of the Helsby 660 volt condensers in large quantities of normal 50 mfd. boxes is about 4s. per microfarad, and the cost per kilovolt-ampere for a pressure of 660 volts at 50 periods is about 2l. 10s., excluding switchgear.

In the case of circuits of lower pressures than 660 [illegible]

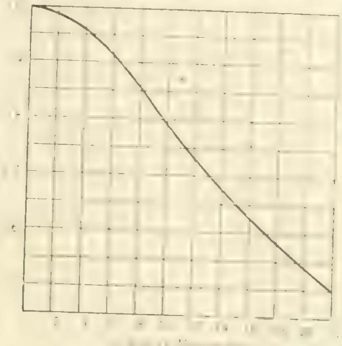


FIG. 7.

[illegible] may be improved by using inductance in series with the condenser (patent No. 21,095/1914). This is due to the fact that the inductance increases the voltage on the condenser. That this is so may be seen from the following considerations. If a condenser [illegible] is placed across the mains a certain leading current will flow, this being, of course, at the pressure of the mains. Assuming that resistance is negligible, an inductance is now placed in series with the condenser, such that there is still a leading current, the [illegible] is reduced, and the voltage across the combination is found by deducting the drop through the inductance from the drop through the condenser. But since this resultant voltage must equal that of the mains it follows that the voltage on the condenser must [illegible]

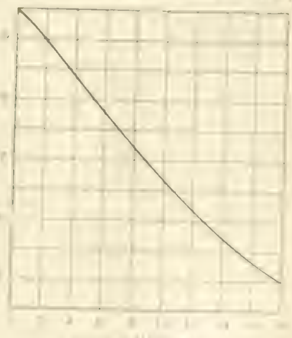


FIG. 8.

[illegible]

n being the frequency and V the voltage. The output of a condenser is calculated from the same formula. Assuming that the pressure is raised from 200 volts to 550 volts by the arrangement, the capacity would be correspondingly reduced from 7,962 mfd. to 2,896 mfd. The output of this condenser is :—

$$\frac{2{,}896 \times 2\pi \times 50 \times (550)^2}{10^9} = 275 \text{ leading k.v.a.}$$

and the current is 500 amperes (at 550 volts). To obtain this current through the condenser and inductance in series, the impedance must be 200/500=0·4 ohm. The admittance of the condenser is 1·10 ohms, so that the reactance of the inductance must be 1·10−0.40 =0·70 ohm. The inductance in henries=reactance/2 πn=0·70/314 =0·00223. The output of the inductance in volt-amperes is given by $2\pi n I^2 \times$ inductance in henries. From this it follows that the capacity produces a leading load of 275 k.v.a., and the inductance a lagging load of 175 k.v.a., so that the resultant load is 275−175 =100 k.v.a. Thus, the use of an inductance, the cost of which is small, shows a saving of about 64 per cent. in the cost of the condenser in this particular instance.

Fig. 7 shows graphically the total capacity (whether on single-phase or on three-phase circuits) that is required on a 550-volt 50 period circuit to correct 1 kw. of load from any power factor up to unity. It is seen that the curve bends over, becoming much flatter, between the power factors of 0·95 and 1·00, showing that a much larger proportion of capacity is required to correct the power factor above 0·95 than below that value. Since a power factor of 0·95 is usually sufficiently high for practical purposes, it is preferable from the financial point of view, to correct only up to that value. Fig. 8 is a corresponding curve showing the capacity that is required to correct the power-factor up to 0·95. Thus, a load of 100 kw. at a power factor of 0·7 would require a capacity of 730 mfd. to bring the power factor up to 0·95.

Notes on the Electric Equipment of Machinery for the Handling of Materials.

Summary.—In this article a number of points are discussed in regard to what may be termed the details of electrical equipment. These include motors, speed regulation, electric braking, controllers, resistors and switchgear.

(*Continued from p.* 502.)

A lifting motor controller is depicted in Figs. 14 and 15. Diagrams showing the whole of the connections, the main connections and the sequence of the switches for this controller are given. With the master-controller in the "off" position, only the track contactor [illegible] and 3A are closed. On throwing the controller handle to the first notch on the "lifting" side [illegible] and 4 are energised; hence these switches close and the motor starts. In this position the whole of the starting resistance is connected in series with the motor, and the series and shunt-resistances are connected in parallel with the armature, Fig. 14(*c*), notch 1, giving slow speed. Switch 2 is opened on the second notch and the resistance, which was in parallel with the armature, is disconnected. The third notch closes switch 7, provided the current has dropped below the setting of the relay-coil R-C_7, cutting out a section of the resistance and increasing the motor speed. In like manner the starting resistance is cut out step-by-step to short circuit on the fifth notch.

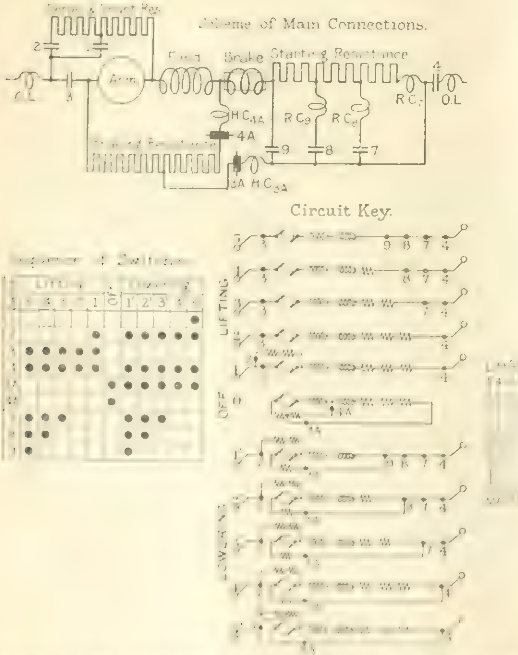


Fig. 14.—Main Connections, Sequence of Switches and Circuit Key [illegible] Fig. 15.

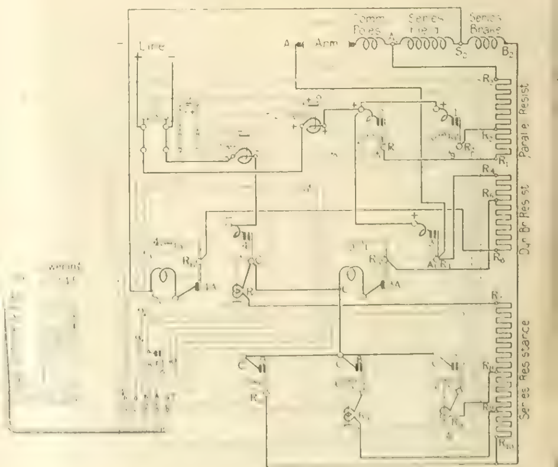


Fig. 15.—Lifting Motor Controller.

Switches 4, 7, 8 and 9 are each equipped with a series relay coil which holds out the next succeeding switch until the line current has dropped to a value corresponding to the relay setting. By this arrangement, automatic acceleration is obtained in case the master controller is moved quickly from the "off" position to any one of the "running" positions, other than the first or second.

In the first lowering position, switches 2, 3A, 4, 7, 8 and 9 are closed. With these connections, the machine operates either as a generator or shunt motor, according as the load on

the hook is or is not sufficiently heavy to overhaul the motor. Increased lowering speed is obtained by moving the controller handle to the second, third, fourth or fifth notches, opening switches 9, 8 and 7 successively, which inserts resistance in the field. On the fifth lowering notch, switch 1 is energised, and this short-circuits a portion of the shunt and series resistances. The lowering speed is a maximum on the fifth notch, but the speed can be decreased in graded steps by moving the master-controller towards the "off" position. This operation closes switches 7, 8 and 9 in order, and the relay coils hold out these switches until the current has dropped to a value corresponding to the relay setting, so that automatic retardation is obtained in case the controller handle is moved more than one notch at a time towards the "off" position. Protection against overloads is provided by two overload relays, *O.L.* Fig. 14, connected one in each side of the line. After the relays have operated they can be re-set by bringing the master-controller to the "off" position. A no-voltage release opens the control circuit on failure of the supply, and the motor cannot be re-started until the controller is returned to the "off" position.

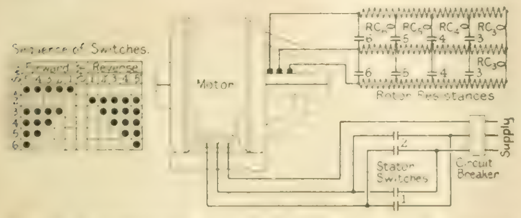


FIG. 16.—MAGNET-SWITCH CONTROLLER FOR THREE-PHASE INDUCTION MOTOR.

The main connections of a three-phase reversing controller are shown in Fig. 16. Acceleration is effected automatically by the accelerating relays, $R.C_3$, &c., which permit the successive contactors to close only when the motor current has dropped to a value corresponding to the relay setting.

With the switch in the "off" position all the contactors are open. When the circuit breaker is closed and the master-switch thrown to the forward position, the coil of switch 1 is energised and the switch closes, connecting the stator winding

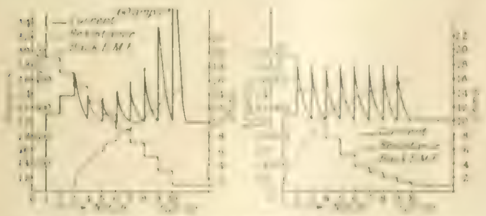


FIG. 17.—CURVES SHOWING THE [illegible] OF [illegible] STARTING [illegible].
(a) [illegible].
(b) [illegible].

to the line and starting the motor with all the resistance in the rotor circuit. The second notch [illegible] switch 3, short-circuiting a portion of the resistance and increasing the motor speed. In like manner, switches 4, 5 and 6 are closed on the third, fourth and fifth notches respectively, cutting out all the resistance and bringing the motor up to full speed.

It will be noted that switch 3 may be operated by either of two relays, each one of which is [illegible] with switch 1 and the other with switch 2. This arrangement is necessary in order that automatic acceleration [illegible] irrespective of the direction of rotation. When running reversed, the motor and controller are operated in a similar manner, with the exception that switch 2 is used for connecting the stator winding to the supply.

RESISTORS.

It is a *physical impossibility* to design an efficient resistor for a low temperature rise. The higher the permissible temperature rise the more efficient will be the resistor for a given weight of material. Except in special cases it is advisable to allow a rise of as much as 300° C., and the materials used must be capable of withstanding high temperatures for indefinite periods.

When the current is small, the resistor should be in the form of a continuously-supported wire or strip mounted upon an insulated tube having great mechanical strength. In our opinion the open helix resistance and the wire-wound porcelain unit should never be used. For currents of too large a value for a wire-wound unit and of too small a value for a cast-grid, various forms of stamped grid are available. Although these are called "unbreakable" many of them are, in reality, highly fragile. The reason for this is that relatively inexpensive resistance materials have to be used, as, for example, silicon steel, and the percentage of stamped grids broken during manufacture may run to a very high figure. This leads to the conclusion that the ideal stamped grid should possess rigidity, and at the same time be highly elastic. To minimise the

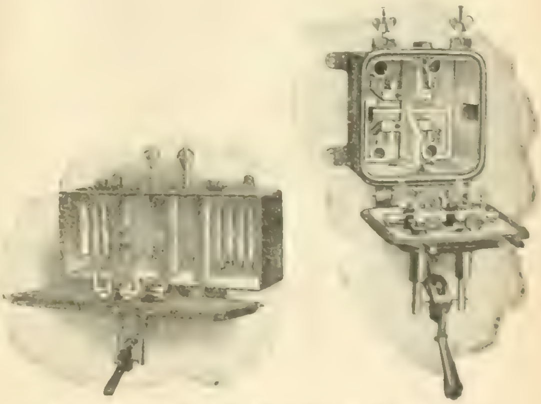


FIG. 18.—[illegible].

percentage of breakage the shape of the grid should be such as to call for the application of no undue strain during the stamping operation. If these conditions be correct, then many of the stamped-grid resistances on the market are capable of improvement.

Resistors for heavy currents are almost invariably made of cast iron. Cast grids should not be used for small currents, as the minimum section necessary to give sufficient mechanical strength is large enough to carry a fairly heavy current. When cast grids are used for small currents they are either unduly heavy or they are [illegible]. [illegible]

[illegible]

SWITCHGEAR.

A good rule to observe in drawing-up specifications for industrial switchgear is to prohibit the use of marble or slate "polished (or enamelled) on the face and edges." Steel plate is an excellent material, and is now largely used on good work. Mica or micanised steel is reliable as an insulator. As their properties become better known it is probable that moulded insulating materials will be used to a large extent. Of these materials, synthetic resins appear to be the most promising.

Relatively inexpensive switches of good design, by Messrs. Vickers, Ltd., are depicted in Fig. 18, the ironclad crane panel being arranged for the protection of three, four and five-motor cranes of various capacities. When a more elaborate system of protection is desired, a circuit breaker may be used instead of a switch and overload relays instead of fuses. An example of this more elaborate protective system is that devised by Mr. G. Ellison. A particularly troublesome job is the design of a satisfactory and inexpensive watertight

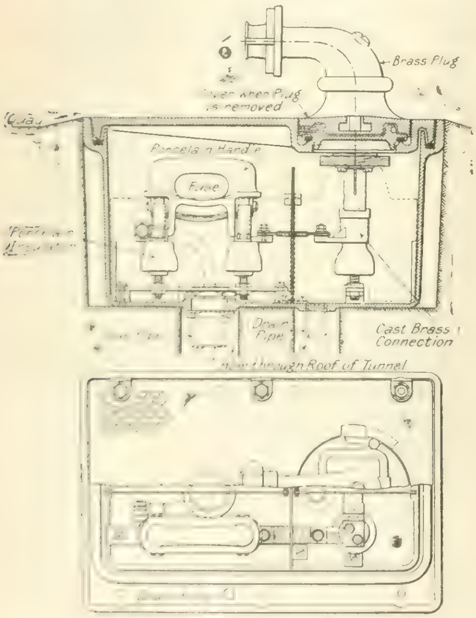


Fig. 19.—Watertight Connection Box.

connection box for a portable motor. The box illustrated in Fig. 19 was made by Mr. G. H. [illegible] for feeding the grain elevators at the new granary at [illegible], and from the drawings it is evident that the small details have been carefully thought out in this case.

Another troublesome job is that of making provision for [illegible] [illegible]. In some instances the arrangement is such as to [illegible] and adequate space for [illegible] and proper insulation [illegible] the [illegible] extent that the [illegible] [illegible] of these joints the [illegible] of the [illegible] depends and [illegible] for a considerable degree of skill.

In the selection of electrical equipment for materials-handling machinery, we suggest that nothing but the best is good enough for the purpose. [illegible] it would be preferable in the long run [illegible] of capital expenditure in ready cases.

Gas-Firing Boilers.

The following is an account of discussions which took place at the Birmingham and Scottish Local Sections of the Institution of Electrical Engineers on Mr. T. M. Hunter's Paper on the above subject. An abstract of the Paper appeared in THE ELECTRICIAN of Nov. 23 and Nov. 30.

DISCUSSION AT BIRMINGHAM

MR. W. N. Y. KING said that to anyone interested in steam raising with coal as fuel the use of other substances as fuel naturally appealed, and for some time past he had made inquiries and notes on this subject and found many points to be remarked in the Paper. He did not agree with the author that lack of books on the subject was the cause of little progress in gas-firing; this was due rather to the fact that gases so used were regarded as waste, and owners and engineers were well satisfied if any gain was made by their use. However, as the author pointed out, we must now aim at the maximum efficiency. An important factor in this connection was the question of dust in the flues. In a Paper on "Waste Heat Boilers in Steam Plants," read by Mr. C. J. Bacon, before the American Iron and Steel Institute (abstract published in the "Mechanical Engineer," July 16, 1915) open hearth practice was referred to, and it was stated that dust was blown off the tubes every six hours. This was a serious item, as in the case of coal-fired boilers two or three times a week was considered quite frequent for this operation. The result of leaving the dust on the tubes was a great loss of efficiency on account of reduction of heat transmission; the amount of this was shown in some figures published in the "Electrical Review and Western Electrician," September, 1917, as follows:—

Thickness of soot on tube... ...	0	$\frac{1}{32}$	$\frac{1}{16}$	$\frac{1}{8}$	$\frac{3}{16}$	inches.
Loss of conductivity...	0	9·5	26·2	45·3	69·0	per cent.

The use of waste products as mentioned had been tried at various times, and the main difficulties to successful working had been reduction of output from the plant due to the large amount of refuse, and the increase in labour costs and difficulty of disposing of the refuse. Even with coal of the quality obtainable at the present day, the handling and disposal of ash and clinker was a serious item of expenditure. The infiltration of air had an appreciable effect on the efficiency. Boilers should be fitted with tight casings, and these maintained in good order to reduce losses to a minimum. No reference was made to explosions, which occurred at times, due to unburned gas accumulating in the flues. These were not often so violent as to disturb the stability of the boiler, but did affect the walls, loosening the joints which had to be made good again if heavy losses due to air infiltration were to be avoided. It would be interesting to have some information from experience with regard to this.

MR. A. GOLDIE ENGHOLM said Mr. Hunter had not given any definite information concerning the costs of gas-firing of boilers, and had not stated whether it was likely to pay large works or electric light undertakings to instal special plant for producing Mond gas or similar gas for boiler-firing. So far as he was aware, it did not pay to put down gas plant to recover the various by-products unless the plant could deal with, say, 200 to 300 tons of coal per day. He noticed that Mr. Hunter stated that for a 30 ft. by 8 ft. Lancashire boiler to evaporate 6,000 lb. of water it would require 71,000 cub. ft. of gas per hour at 107 therms per cub. ft. If the gas could be supplied at 1½d. per 1,000 cub. ft. this would work out at about 9s. per hour for the gas alone. He did not think that at present gas at 107 therms could be supplied at 1½d. per 1,000 cub. ft.

MR. R. L. GOOLD said, in reading the Paper, the author added a remark upon flame temperature, and emphasised the importance of minimising the excess of air. The admitted air, even when pre-heated, was, he assumed, at a temperature of about 100 or 200°C. The excess air had to be raised to the heat of the burner, a temperature, he assumed, of about 1,200 or 1,500°C. The consequent reduction of calorific intensity was obvious. We had to operate between this evil and the evil of unburnt gases in the stack. It was pertinent to remember that these unburnt gases in the stack probably consisted largely of combustible gases which had been manufactured in the flame, as distinguished from gases which had escaped from the burner. The combustion of a hydrocarbon involved an interesting succession of processes. We saw them illustrated in a deep incandescent coal fire. If there was a generous supply of oxygen at the base of the fire, part of the carbon burned to form carbondioxide. In ascending within the interior of the incandescent coal through a region in which an inadequate supply of oxygen prevailed the inert dioxide was converted into the combustible monoxide. The carbon monoxide was seen to burn upon the surface of the incandescent coal with a lambent blue flame. In a non-Bunsen gas flame combustible gases were generated in the flame. Almost every flame was hollow; the interior was unburnt gas from the burner. In the lower part of the flame, however, a portion of the gas burned with an insufficient supply of oxygen, carbon monoxide was produced and [illegible]. We recognised the existence of these regenerated gases when utilising the reducing blow-pipe flame. The gases which were regenerated had a high temperature, and actively extracted oxygen from the [illegible] toward which they were directed by the blow pipe. In a [illegible] burner the process of regeneration was augmented. Admitted with the gas in the hollow interior of the flame was a proportion of air insufficient for complete combustion, but sufficient to promote the process of regeneration. With a flame burning in an unlimited atmosphere substantially all of the regenerated gases ultimately burned in the upper or outer part of the flame. But in a steam boiler the conditions were [illegible] and difficult. It was conceivable that the wetted

surface of the boiler might be the means of so reducing the temperature in a region in which the regenerated gases were liberated that they escaped combustion. The importance of thoroughly mixing the air was emphasised in the paper. This mixing of the air with the gas was, however, a matter of the greatest difficulty, and the regenerated gases escaped combustion on this account also. The speaker's attempt to analyse the process of combustion was, therefore, submitted as a basis for an inquiry as to whether the desideratum of substantially complete combustion with a minimum of excess air could be more nearly attained by a gas-fired boiler, the design of which was founded, *inter alia*, upon a recognition of the existence of combustible gases generated in the flame.

DISCUSSION AT GLASGOW.

Mr. J. H. R. KEMNAL said the conditions applying to gas firing varied with the kind of gas used. There was little advantage in merely producing gas for firing it under boilers. It could only pay with recoverable by-products at a certain figure. With regard to blast furnace gas, there was usually an ample surplus for all blast furnace purposes, and the highest possible efficiency was not necessary to the working of the plant. He maintained the water tube boiler had many advantages over the Lancashire boiler in the utilisation of blast furnace gas. Dust in water-tube boilers could be got rid of in a manner which was not possible with the Lancashire boiler. Results had shown that washing the gas did not improve efficiency, due to the fact that a great deal of the heat is lost in the process of washing. The design of furnace depended upon many conditions of working which varied; no particular practice was applicable to all cases. Investigation was essential, and it was frequently found that the best arrangement was arrived at by trial alone.

Mr. F. ANSLOW wished to know more of Mr. Hunter's actual experiences with [illegible] per cent. efficiency [illegible] plant. Coke oven gases could be better utilised in steam raising than in gas engines, but he advocated the [illegible] of coke oven and blast furnace gas under the same boiler. Under present conditions it was difficult to discover the relation of price as between by-products and the cost of coal.

Mr. W. M. [illegible] said that the Lancashire boiler, though steady and reliable, had practically no opportunity for variation, whereas the water-tube boiler could be designed to meet any conditions. He was inclined to think the line of [illegible] of waste gases would go along the lines indicated in the Paper—viz., gas-firing boilers to drive steam turbines [illegible] gas engines.

Mr. R. B. [illegible] asked if it was [illegible] to use gas firing in conjunction with coal firing.

Mr. [illegible] said he would like to know if Mr. Hunter had had experience of washed gas [illegible] on boiler tubes. The figure given by Mr. Hunter for the value per ton for steam at collieries was [illegible] per ton. That did not apply in Scotland, [illegible] colliery proprietor had recently given [illegible] per ton. With suitable water, there was nothing to beat water-tube boilers for gas firing. He asked if Mr. Hunter had had [illegible] between coke ovens.

Mr. HUNTER, in reply, said that [illegible] [illegible] could be economical [illegible] than [illegible] coal firing. He would not attempt to [illegible] Lancashire boiler with producer gas, as you could not get at the [illegible]. The figure of [illegible] per cent. was obtained in two [illegible] boilers at a Yorkshire power station put down [illegible] of coke-oven and blast furnace gas [illegible]. It was possible to arrange that gas-fired boilers could be [illegible] when necessary.

Physical Society.

A meeting was held on November [illegible], 1917, at the Imperial College of Science, Mr. W. E. [illegible], M.A., Vice-President, in the Chair.

A Paper, entitled

"Some Problems of Stability of Atoms and Molecules,"

was read by Prof. J. W. NICHOLSON, D.Sc.

The Paper [illegible] with the possible existence and stability of atoms and of [illegible] formed after the manner suggested by Stark, the link [illegible] in a molecule being provided by a stationary electron on the molecular axis. [illegible] the Rutherford model [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] degree of stability. [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]

The Paper [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] formed by the attachment of an electron after the manner of Stark. This is a further argument against the possibility that two atoms in a molecule can be linked by a single electron, or by two electrons, which attract both atoms.

Mr. T. SMITH asked if it would be possible to make some such generalisation as that symmetry in the system was essential to stability.

Dr. BORNS asked what was meant by the statement that the atom with $+5e$ and $-7e$ is strongly represented in the solar corona.

Dr. R. S. WILLOWS said it was of great advantage that eminent mathematicians were investigating the suggested models of the atom and attempting to compare the results with experiment. Stark had made some brilliant experimental discoveries, but his theoretical deductions appeared to be faulty.

Prof. NICHOLSON, in reply, said he thought some such generalisation as that suggested by Mr. Smith could be made. At any rate, the greater the symmetry of the system the more liable it is to be stable. In reply to Dr. Borns, he meant that certain lines of strong intensity in the spectrum of the corona were referable to such a system.

An Exhibition of the

Uses of Certain Methods of Classification in Optics

was given by Mr. T. H. BLAKESLEY, M.A.

This consisted of an account of the additions which, in the course of the intervening years, he had been enabled to make in the general diagram of optical properties, first communicated by him to the Physical Society in the year 1903 ("Proceedings," Vol. XVIII., p. 591). The plan pursued is to take as variables the ratios which the radii of face curvature bear to the thickness between the faces along the axis. By this means the shape of the lens is given by the two rectangular coordinates alone, and any possible property dependent upon a function of these coordinates will be represented by a line upon the diagram. When two such loci intersect, the lens corresponding to the points of intersection possesses both the properties corresponding to the lines. A point much dwelt upon by the author was the very large number of straight-line loci corresponding to properties of value in a lens, and of these very many are parallel, and, cutting the axes at 45 deg., may be most simply defined by the value of the intercept of the axis.

It was pointed out that, in general, a lens may have its radii of face curvature both multiplied by [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]

In another [illegible] [illegible]

In another, [illegible] of the cylinder in their original position will be achromatic.

In another, telescopic; and so for many others. Other straight [illegible] [illegible] [illegible]

[illegible]

[illegible]

Mr. T. [illegible]

[illegible]

Mr. [illegible]

Patents Expiring in 1918.

The following is a list of patents of interest to electrical engineers, which, unless extended by the Privy Council, will expire during 1918. The list does not include any patents granted in 1904 which have since for any reason become void.

No.	Date (1904).	Name of patentee.	Subject of patent.
658	Jan. 11	W. Fairweather (Cutler Hammer Mfg. Co., U.S.)	[illegible]
1,242	Jan. 18	W. W. Dean	Party ... telephone systems.
1,307	Jan. 18	I. Moscicki	Electric condensers.
1,308	Jan. 18	I. Moscicki	High-tension electric condensers.
1,494	Jan. 20	M. Latour	Alternate current dynamos.
2,093	Jan. 27	M. Leblanc	Systems of excitation for induction machines.
2,096	Jan. 27	A. F. Berry	Apparatus for distribution of alternating currents.
2,098	Jan. 27	Cie pour la Fabrication des Compteurs et Matériel d'Usines à Gaz	Induction Meters.
2,273	Jan. 29	R. A. Hadfield	Magnetic material.
2,361	Jan. 30	B.T.-H. Co. and F. Samuelson	Emergency governing devices.
2,449	Feb. 1	B.T.-H.Co.(G.E.Co.,U.S.)	Emergency brakes.
2,453	Feb. 1	B.T.-H.Co.(G.E.Co.,U.S.)	Alternating-current motors.
3,169	Feb. 9	F. T. Cash	Suspension chain for electroliers.
3,216	Feb. 9	W. T. Henley's Telegraph Works Co. and W. H. Nichols	Fuse-box for cables.
3,328	Feb. 10	A. P. & G. C. Lundberg	Switches.
3,896	Feb. 16	C. H. Merz & B. Price	Protection of apparatus on a.c. systems.
4,075	Feb. 18	H. L. Doulton and C. E. Morris	Supports for conductor rails of electric railways.
4,869	Feb. 27	G. Marconi	Wireless telegraphy.
4,991	Feb. 29	A. J. Boult (L. Maquaire, France)	Sparking plugs for explosion engines.
5,113	Mar. 1	Marconi's Wireless Telegraph Co. and A. Gray	Transmitters for wireless telegraphy.
6,724	Mar. 19	H. Aron	Electricity meters for alternating currents.
[illegible]	Mar. 21	[illegible]	Terminal attachment for conducting wires.
[illegible]	Mar. 22	H. C. Lewis (G.E. Co., U.S.)	Filaments, and manufacturing same.
7,056	[illegible]	[illegible]	Production of metals of ... electrolysis.
[illegible]	Mar. 26	... M. Hardingham	Secondary batteries.
[illegible]	[illegible]	[illegible]	[illegible] controller handle.
[illegible]	[illegible]	[illegible]	[illegible] electric vehicles.
[illegible]	[illegible]	... U.S.)	[illegible]
[illegible]	[illegible]	[illegible]	...tric vehicles.
[illegible]	[illegible]	C. H. Merz and B. Price	[illegible]
[illegible]	[illegible]	[illegible] Kando, H.	[illegible]
[illegible]	[illegible]	B.T.-H. Co. [illegible]	[illegible]
[illegible]	June [illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible] telegraphy.
13,777	June 17	E. Haefely	Apparatus for manufacturing insulating sockets.
13,933	June 20	A. J. Boult (Norman Dodge, U.S.)	Storage battery separators.
13,304	July 8	B.T.-H.Co.(G.E.Co.,U.S.)	Electric controllers.
15,453	July 11	C. Oliver	Arc lamps.
15,634	July 13	S. Ferguson	Systems of electrical distribution.
15,704	July 14	N. M. Mordey and G. C. Fricker	Electricity meters.
15,796	July 15	C. H. Merz and B. Price	Alternate-current distributing systems.
16,340	July 23	W. C. Lea	Electric couplings.
16,595	July 27	S. G. Leach and E. Bergtheil	Supporting devices for electric fans.
17,020	Aug. 3	B.T.-H. Co. (G.E. Co., U.S.)	Emergency devices for brake systems.
17,423	Aug. 10	H. & E. Rosenberg	Self-regulating dynamos.
17,808	Aug. 16	Evershed & Vignoles and S. Evershed	Electrical measuring instruments.
17,811	Aug. 16	B.T.-H.Co.(G.E.Co.,U.S.)	Automatic brakes
18,403	Aug. 25	C. P. Townsend	Electrolytic process, &c.
19,475	Sept. 9	O. Imray (Siemens-Schukert Werke G.m.b.H., Germany)	Electric cranes or the like.
19,572	Sept. 10	B.T.-H.Co.(G.E.Co.,U.S.)	Controlling circuit-breakers
19,993	Sept. 16	Evershed & Vignoles and E. B. Vignoles	Shunts for electrical instruments of moving coil type.
20,010	Sept. 16	C. C. Regnart and Hunter Elec. Candle Lamp Co.	Holder for electric lamps.
20,277	Sept. 20	C. D. Abel (Siemens & Halske A.G., Germany)	Manufacture of incandescent bodies for glow lamps.
20,314	Sept. 21	W. Dixon	Electric capstans.
20,536	Sept. 23	W. J. Smith	Bath for therapeutic treatment by electric and other radiant energy.
20,552	Sept. 23	B.T.-H.Co.(G.E.Co.,U.S.)	Dynamo electric machines.
20,898	Sept. 28	E. J. Chambers	Additions to pipes or tubes for underground cables.
20,968	Sept. 29	J. S. Highfield	Central station electric installations.
21,640	Oct. 8	Marconi's Wireless Telegraph Co., E. Berry and H. A. E. Ewen	Apparatus for wireless telegraphy.
21,841	Oct. 8	Marconi's Wireless Telegraph Co., E. Berry and H. A. E. Ewen	Safety devices in connection with radio-telegraphic transmission circuits.
22,236	Oct. 15	A. J. Bonnella	Electric lamp fittings.
22,342	Oct. 17	Korting & Mathiesen A.G.	Arc lamp electrodes.
22,637	Oct. 20	A. J. Boult (L. Maquaire, France)	Sparking plugs for explosion engines
[illegible]	Oct. 22	B.T.-H. Co. and B. Hopps	Electric power transmitting mechanism.
23,622	Nov. 1	P. Möllmann	Galvanic batteries.
[illegible]	Nov. 1	P. W...	Electrical buoy light.
[illegible]	Nov. 1	E. B...	Magnetic brakes for vehicles.
[illegible]	Nov. 12	[illegible]	Dynamo electric machines.
[illegible]	Nov. 14	J. H. [illegible]	Electric clocks.
[illegible]	Nov. 16	J. A. Fleming	Instruments for detecting and measuring alternating currents.
[illegible]	Nov. 17	B.T.-H. Co. (G.E. Co., U.S.)	Electric switch operating mechanism.
[illegible]	Dec. 6	B.T.-H.Co.(G.E.Co.,U.S.)	Electrical distribution.
[illegible]	Dec. 9	C. M. Dorman, R. A. Smith and H. G. Ba...	Switches and cut-outs.
[illegible]	Dec. 9	B. J. B. Mills (T. A. Edison, U.S.)	Storage batteries.
27,000	Dec. 9	D. L. Lindquist	Electromagnets.
27,083	Dec. 10	J. A. Fleming	Kummeters, or instruments for the measurement of wave lengths in wireless telegraphy.
[illegible]	Dec. 20	H. [illegible]	Electric apparatus for watchmen's electric control, &c.
[illegible]	Dec. [illegible]	J. [illegible] and F. Suchanek	[illegible] connecting subscribers to telephone exchanges.
[illegible]	Dec. [illegible]	H. Kuzel	Light emitting bodies for electric lamps.
28,155	Dec. [illegible]	Phoenix Dynamo Mfg. Co. F. [illegible]	Dynamo electric machines.
[illegible]	Dec. [illegible]	J. H. W. [illegible]	Telegraph transmitting instruments.
[illegible]	Dec. [illegible]	[illegible] de Ferranti	Electric welding.

No.	Date (1904).	Name of patentee	Subject of patent.
28,522	Dec. 28	W. J. Mackenzie	Electric signalling on railways.
28,546	Dec. 28	H. H. Berry	Armour-clad switch fuses.
28,554	Dec. 28	A. J. Boult (W. Hoskins, U.S.)	Thermo-electric couples.
28,968	Dec. 30	Masch. [illegible]	Series commutator motors for l.p. alternating current.
29,065	Dec. 30	H. W. Butler ..	Dry batteries.
29,074	Dec. 30	J. A. Rey	Metal reflectors for electric lanterns.
29,167	Dec. 30	R. H. Davis & A. Graham	Telephones for dining, &c.
29,422	Dec. 31	A. T. Dawson and G. T. Buckham	Electrical apparatus for transmitting and receiving signals.

Provisional Electric Lighting Orders.

The following is a complete list of applications for provisional orders deposited with the Board of Trade on or before the 21st ult., under the provisions of the Electric Lighting Acts, 1882 to 1909 :—

Title of order and description of area.	Promoters.
Braintree urban district	Crittall Mfg. Co. (Ltd.)
Braintree urban district .	Urban District Council
Clayton and Queensbury urban districts	Electrical Distribution of Yorkshire (Ltd.)
Crompton urban district	Urban District Council.
Doncaster rural district (parishes or townships of Cadeby Conisbrough, Denaby, Edlington, Sprotbrough and Warmsworth)	Electrical Distribution of Yorkshire (Ltd.)
Gainsborough urban district	James Marshall.
Gildersome urban district.................	Electrical Distribution of Yorkshire (Ltd.).
Greasbrough urban district	Urban District Council.
Guiseley and Menston (urban district of Guiseley and parish of Menston in rural district of Wharfedale)	Electrical Distribution of Yorkshire (Ltd.)
Halifax (extension to Luddenden Foot and Mytholmroyd)	[illegible]
[illegible]	Urban District Council
[illegible]	Urban District Council
[illegible]	[illegible]
[illegible]	Electrical Distribution of Yorkshire (Ltd.)
[illegible]	Electrical Distribution of Yorkshire (Ltd.)
Royton urban district......................	Urban District Council.
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	Electrical Distribution of Yorkshire (Ltd.)

Pacific Cable Board.

[illegible]

. The net traffic receipts exceeded those of 1915-16 by £26.127 10s. 3d., owing mainly to the large volume of Government and other traffic created by the entry of Australasian forces into the European theatre of war. The expenditure (excluding special appropriations) increased by £13.951 8s. 10d. over that of the preceding year and £17,594 over the original estimate.

In the preliminary forecast of revenue and expenditure for the year ending March 31, 1918, the traffic revenue is put at £260,000, the working expenses are estimated at £134,711, [illegible] (£39,150), the excess is £86,139. The investments for account of the renewal fund were valued on March 31, 1917, at £291,067.

Throughout the year the cables have worked without interruption and no repairs have been called for. The depots, instruments and plant generallly have been maintained in a high state of efficiency. The main cables have been worked continuously throughout the year and the long sections, viz., Fanning Island—Bamfield and Fanning Island—Suva were worked at full load day and night with practically no clear periods at any time during the whole year. The land line between Montreal and Bamfield (leased from the Canadian Pacific Railway Co.) enjoyed a year of comparative freedom from serious interruption. The land line between Melbourne and Sydney which has been handed over to the Board by the Commonwealth Government has also worked well. The Board's house property at the various stations has been maintained in satisfactory repair. No additions to buildings were made during the year under review. Electric lighting and power plant is in course of being installed at the Suva station. Electric lighting will improve the conditions of working and the cost of maintenance will be considerably less than acetylene gas. Moreover, the plant will provide power for the running of apparatus. The total cost of the installation, including the power-house, will be approximately £1,000. Communication with the Fanning Island station was provided during the year by the charter of the auxiliary schooner "Flaurence Ward," in April, 1916, and February 1917, and of the S.S. "Kestrel," in August 1916 and October 1916. The "Iris" made a call in June 1916. The progress of construction of the auxiliary schooner for the Fanning Island service has been impeded by the difficulties of obtaining requisite material. The schooner will be named "Tangaroa" and her status will be similar to that of the "Iris." The Board's cable maintenance vessel "Iris" continues in first-class condition. The "Iris" was commissioned on two occasions during the year under review.

Sir William H. Mercer, K.C.M.G., retired from the Board towards the end of 1916 and he was succeeded by Mr. H. C. M. Lambert, C.B., of the Colonial Office. The general health of the staff during the year has continued satisfactory. Notwithstanding the conditions of abnormal pressure and strain which have obtained almost without intermission since the outbreak of war, the staff have fully maintained the high level of loyal and efficient service with which the Board have been gratified in past years. A number of experienced operators withdrew from the Board's service during the year, mostly to join the colours. There has been great difficulty in filling their places and supplying the additional staff required for dealing with the present volume of business. Mr. R. G. McLachlan, who had held the position of superintendent in the Board's service in Canada since 1902, retired in May, 1917. His successor has not yet been appointed. In view of the further substantial rise in the [illegible] for the year 1917 to the equivalent of 20 per cent. of net salary.

[illegible] traffic were transmitted across the Pacific Cable. In add[illegible] which could be dealt with on the B[illegible] known at present. Unless, therefore, [illegible] of the United States Expeditionary F[illegible]

Books Received.

[illegible]

The Electrician.

FRIDAY, JANUARY 4th, 1918.

Editorial and Publishing Offices:—

8, BOUVERIE STREET, LONDON, E.C. 4.

Telephone: City 9853 (4 lines). *Telegrams:* "Bentrotric Fleet London."

1917.

In looking over the events of 1917 it is not evident that electrical engineering has very much to its credit, at least so far as we may judge by the record of the year's work in our pages. This does not mean, however, that important work has not been done. Indeed, the facts are quite the reverse. During the past 12 months the electrical engineer has undoubtedly been prominent, and much progress has been made, but owing to the special conditions under which our national life is at present carried on it is inexpedient for details to be published. For this reason, much that we can say on the present occasion has only an indirect, but nevertheless important, bearing upon the electrical industry; such, for example, as the preparations for the future for meeting the new conditions which must arise after peace is declared.

One of the most important movements during the past year has been that having for its object the re-organisation of electricity supply in this country. Considerable progress has been made in drawing up schemes for interlinking some of our larger power stations, though where actual construction is necessary any considerable modifications are hampered by more pressing claims. Last March a meeting of the Lancashire and Cheshire Committee was held, at which Mr. G. H. ROBERTS, M.P., Parliamentary Secretary to the Board of Trade, was present. The whole question of placing the Lancashire and Cheshire districts on a more satisfactory basis was discussed, and in August a report was issued in which certain recommendations were made. In this report a Joint Board is contemplated, consisting of representatives of the local authorities and companies concerned, the number of representatives for any undertaking depending upon the population served or upon the capital involved. The existing rights of electrical undertakings as distributors are to be observed, and a basis is outlined for determining the charges for supplies of electricity, either as bulk supply, or as stand-by, emergency and reciprocal supplies. There was also a supplementary report which was not signed by all the representatives, in which it was sought to confer considerably greater powers upon the Joint Board so that they would be able to erect and operate power stations and to purchase the less efficient stations, so that these would be superseded as might be found desirable.

The whole question of power supply is also being considered from the national point of view by the Board of Trade Committee on Electric Power Supply, which was appointed in March, with the Right Hon. F. HUTH JACKSON as Chairman. For reasons of health Mr. JACKSON resigned the Chairmanship, and was succeeded by Sir ARCHIBALD WILLIAMSON, and, as it was felt by the municipalities that they were not sufficiently represented, three municipal representatives were added in July. The Committee issued some brief interim conclusions in May, very soon after their appointment, so as to express in general terms their attitude towards some well recognised points, such as the national importance of electric power to our industries and the great desirability of establishing a comprehensive system for the generation of electricity. The Committee is still sitting, and it is not to be expected that its report will be available for some considerable time, owing to the mass of evidence that is being taken. Considerable interest, however, has been aroused recently by the publication of the report of the Coal Conservation Committee of the Reconstruction Committee, in which a number of recommendations are made of a drastic character with a view to placing the electricity supply of this country upon a satisfactory basis. A matter of some difficulty is the conflicting views expressed by those responsible for municipal undertakings and private enterprise. In this connection it is interesting to note that the Incorporated Municipal Electrical Association issued in August a statement in favour of the creation of district boards under a central board, or commission, for control, which would take over the whole of the duties at present exercised by the Board of Trade, the Local Government Board, the Home Office and other departments, in so far as they relate to the administration of the Electric Lighting Acts, the central board having full powers, but not being authorised to own or operate electricity works.

Among the many problems which must be considered by the Board of Trade Committee is the question of wayleaves, which is at present in a most unsatisfactory position. The subject was brought into some prominence by a Paper before the Institution of Electrical Engineers by Mr. C. VERNIER in the early part of the year, in which it was shown that supply authorities wishing to run overhead lines are very greatly hampered by both obstruction and cost. This arises not merely from the unreasonableness of private owners, but also through the obstructive action of local authorities. A Bill to deal with the matter has actually been drafted by a Joint Committee of the Incorporated Association of Electric Power Companies and the Incorporated Municipal Electrical Association, by which it is proposed to confer powers upon the Board of Trade to refer any case in dispute to an arbitrator, who would have power to fix terms upon which a wayleave should be granted in any particular case. So far nothing further has been heard of this Bill, and it is doubtful whether time can be found in Parliament under existing conditions for its consideration.

One effect of the war has been the stimulation of electricity supply, of which more will be heared in due course. As an example, we may refer to the case of Sheffield, where the output in 1914 was 26½ million units; during the last financial year the output rose to 126½ million units, and during the current financial year it is expected to rise to 172 million units. Generally speaking the expansion has been due to the great increase in the electric driving of factories. Marked expansion, however, has also taken place in other directions, notably in the employment of the electric furnace in the manufacture of steel. At Sheffield the great increase in output is largely due to this cause. Thus, in June, Mr. S. E. FEDDEN stated that the capacity of electric furnaces then connected to the Corporation mains was 27,350 kw., and it has doubtless increased since that date.

Another direction in which the effect of the war has been felt has been on the tramways. In various parts of the country a number of regrettable accidents have occurred, due partly to the impossibility of maintaining rolling stock and track in proper condition, and partly to the fact that most of the younger men have been called to the colours. Consequently it has been necessary to carry on in many cases with the addition of inexperienced men and with women. Accidents have occurred, notably at Dover, Dudley, Bradford, Wigan and Glasgow. So far back as last January Mr. JAMES DALRYMPLE thought it desirable to issue a memorandum to his staff at Glasgow, calling attention to precautions which should be taken in order to minimise

accidents under the present unusual conditions. A Committee has now been appointed by the Board of Trade to control tramway material and stock so that it is utilised to the best advantage.

Another feature of electric traction has been the increasing use of the electric vehicle on the road and more particularly as small trucks in the works.

In electric lighting there have been no fresh developments. Public lighting is very naturally at a standstill, though the restrictions, as far as London is concerned, are nothing like as severe as they were a year or more ago, as it has been demonstrated that the mere obscuring of public lighting cannot hide a large city. An event of some interest was the publication in August of a street lighting specification by the Joint Committee appointed to consider this question. Complete agreement in the matter was not reached, and therefore the standard clauses have been published as a majority report along with a minority statement. Possibly in more peaceful times the effort will be renewed to obtain agreement on the subject.

The position of fuel for electricity supply stations has remained somewhat acute. It has been difficult to obtain sufficient coal and the coal that has been available has been of a poor quality, so that the capacity of many of the power stations has been seriously reduced. In order to relieve the position generally, a scheme of distribution was drawn up by the Controller of Coal Mines in July last, which is now in operation. The object of the scheme was to prevent unnecessary use of rolling stock, and with this object in view the country was divided up into districts, the requirements of each district being supplied from certain centres, either near or within the district itself.

Among the matters which have been given serious consideration owing to the prolonged nature of the war has been the fixation of nitrogen. In 1916 the Minister of Munitions appointed a committee to consider the whole subject, and a statement was issued recently showing that very considerable progress has been made. The Minister has under consideration a scheme for the manufacture of cyanamide, and valuable work has been done in regard to the direct synthetic production of ammonia. Meanwhile the United States, having entered into the war during the early part of the year, acted vigorously in regard to the nitrogen problem, and voted the large sum of [illegible] for that purpose.

The trade of the country during the past year has been carried on with considerable difficulty, partly owing to Government control, involving many restrictions, and partly due to financial considerations. Protests against Government control have been made by the Merchants' Committee of the London Chamber of Commerce and these protests were approved by the Chamber of Commerce last October. It was felt that [illegible] With regard to the financial aspect this is largely centred round the question of [illegible] profits. During the last Budget [illegible] per cent. [illegible] policy is being followed in Germany, where special reserve funds are being created by many German companies, while some of them are increasing their capital by large amounts. We were glad to note in July that the Government saw the desirability of allowing depreciation on plant and stock to a certain extent in making assessments, a White Paper being issued on the subject. At the beginning of the year electricity supply companies were fortunate in securing the right to raise their statutory percentage from 6 to 7½ per cent.

It is only natural that the foreign trade of the country should have received marked attention during the past year, rather in reference to the future than for our immediate needs. The question of utilising the confidential information collected by our Consuls and commercial attachés was considered early in the year by the Association of Chambers of Commerce. It has generally been felt by such bodies that information of this kind is of the greatest importance, but that it has so far been badly collected and not rendered available with sufficient rapidity. In order to meet this feeling, the whole question of the Consular service and the information which such a service should be capable of supplying to the commercial men of this country has been under the consideration of the Government. In July the Federation of British Industries published a number of recommendations made to the Government, the object being to improve the Consular service; and shortly afterwards the Government announced that they had approved a scheme for the creation of a new commercial intelligence department, which would act somewhat as a link between the Foreign Office, to whom the commercial attachés were responsible, and the Board of Trade, which was responsible for the publication of the information so obtained. This important step has now been taken, and Sir A. STEEL MAITLAND has been appointed Parliamentary Secretary of the new department.

As the outcome of the deliberations of Lord FARINGDON'S Committee, whose findings were in favour of the formation of a trade bank, a Royal Charter has been granted to the British Trade Corporation. Considerable criticism was aroused by the charter, as it was felt that the powers would enable the Corporation to carry on commercial transactions in competition with other commercial concerns rather than acting merely as a trade bank for promoting British trade in general. This view was taken by the London Chamber of Commerce, and adverse criticism was voiced in Parliament, but the position was [illegible] up to some extent by a declaration of policy. Sufficient time has not elapsed for serious work to have been undertaken by this new Corporation.

[illegible]

[illegible]

[illegible]

MOND's interesting lecture before the Institution of Civil Engineers upon "Foreign Trade and Foreign Investments."

In connection with foreign trade the possibility of introducing decimal coinage and the metric system in this country has received a fresh impetus. A special lecture was given by Mr. HARRY ALLCOCK before the Institution of Civil Engineers last March. As is well known, Mr. ALLCOCK is a keen advocate of the system. On the other hand, a Paper was read by Mr. W. R. INGALLS before the Institution of Mining and Metallurgy, stating the American point of view against the system. There has been much discussion as to whether the £, the florin or the shilling should be the monetary unit to be adopted in this country. This controversy has now been brought to a conclusion by the Institute of Bankers, which has formally decided in favour of the £ as the unit. Since this decision the Association of Chambers of Commerce of the United Kingdom and the Decimal Association have come into line with the Institute of Bankers. It appears, therefore, that some progress has been made towards decimal coinage, but the metric system is a more difficult problem to solve. Further discussion on the subject was held quite recently before the Institution of Electrical Engineers, without a very definite result.

Industrial research has been before the public in increasing prominence, not only in this country, but in others. For example, a large national laboratory is to be established in Japan, and steps of the same kind as we are contemplating in this country have been under discussion in the Australian Commonwealth and in South Africa. Last September the Committee of the Privy Council for Scientific and Industrial Research published its second report, which showed very considerable progress in a somewhat difficult movement. Perhaps the most important innovation was the establishment of a Fuel Research Board, consisting of Sir GEORGE BEILBY, as Chairman, and the Hon. Sir CHARLES PARSONS and Sir RICHARD THRELFALL. A Sub-Committee was appointed later to consider the problem of Irish peat. In October the first report of the Fuel Research Board was published, and indicated its general line of policy.

There has been a considerable amount of educational discussion, partly technical and partly general. The technical training of the chemical engineer was considered at a discussion held by the Faraday Society last February, whilst in November the scheme for dealing with the education of engineers and apprentices with which Messrs. A. E. BERRIMAN and A. P. M. FLEMING are associated, was considered at a very representative meeting, and a council was formed to carry through a scheme involving much closer co-operation between manufacturers and educational authorities than has been evident in the past. In regard to general education and the position of Labour during the past year, we hope to make some remarks in a future issue.

Our engineering societies have been as active as can be expected under the circumstances. A number of Papers have been read before the Institution of Electrical Engineers, and Mr. C. H. WORDINGHAM in his Presidential Address outlined a very progressive policy. The event of the year, so far as the Institution was concerned, was the adoption of proxy voting, so that provincial members might take a greater share in the affairs of the Institution. A good deal of criticism was aroused by the proposal, and there is some doubt as to whether the scheme will work out to the real advantage of the Institution.

We have had to mourn the loss of several well-known men during the past year, including one of our most brilliant experimentalists, Mr. W. DUDDELL, at an early age; Mr. JOHN [illegible], of the Board of Trade; Mr. J. S. RAWORTH, who was concerned with much of the pioneer power work of the electrical industry; Mr. J. G. LORRAIN and Mr. W. R. SYKES, both of whom were pioneers in other directions; and Mr. H. A. C. Saunders and Mr. R. M. Sayers, who were prominently connected with submarine telegraphy. Norway has lost Prof. K. BIRKELAND, the originator of the Birkeland-Eyde process for the fixation of nitrogen; and America Dr. E. F. ROEBER, one of the founders of the American Electrochemical Society.

Correspondence.

THE GIVING OF PROXIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I fear I cannot congratulate you on the tone of the note to my letter which you published in last week's issue.

You state two things for which I must ask you to produce any evidence whatever.

First, the Council would not have called the meeting if they had not been in favour of expulsion.

Secondly, every proxy given to the Council was given against the member.

This latter statement is at once seen to be untrue on the bare fact that my proxy was given to the Council on no definite mandate, but to enable them to act as they deemed best for the Institution.

As regards the first point, if you will consult the rules you will see that a meeting can be called independently of the Council if the Council refuse to move, and they were, therefore, acting in the best interest of the Institution in themselves calling the meeting *to consider the matter*.

You make a great play on the point of British justice, but apparently desire to deny it to the Council.

I do not propose to continue this discussion, for it is obvious that you are biassed against the Council; but, since you have appealed to British justice, I should advise you to study the procedure in British law when dealing with cases of complaints made by one party against another, which come before a magistrate or a judge, when you would see how close is the parallel between the action taken by the Council in this case and the ordinary legal forms. I am, &c.,

Watford, Dec. 28. M. J. E. TILNEY.

[It is evidently hopeless to express our views to our correspondent; they have already been made quite clear. The imputation of bias does not strengthen his case. As to his two points, the Council are not under an obligation to call a meeting if they do not think a good case has been made out: every proxy given was doubtless not intentionally given against the member, but was so given in effect. We cannot devote more space to this subject. ED. *E*.]

PRODUCTION OF DUCTILE TUNGSTEN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the lecture given by Mr. Sydney Johnstone at the London School of Economics on the subject of the Rarer Key Metals, as published in the Dec. 2 issue of the "Daily Telegraph," the following statement is made with reference to tungsten:

"A small quantity is employed for the production of filaments for incandescent electric lamps. The manufacture of ductile tungsten for this latter purpose was not carried on in this country before the war."

Mr. Johnstone has evidently been misinformed on this point, because The British Thomson Houston Co. were supplying their whole requirements of ductile tungsten for Mazda lamp filaments in 1912 by manufacture at their Rugby works. At that time, and until within a month or two from the date of the outbreak of war, the raw material used was tungsten oxide, but the Company, foreseeing a possible shortage of that material, immediately started the manufacture at the outbreak of war of the metal from the raw ore.

This ore, which is of British origin, has always been available in sufficient quantities to supply the needs of the lamp industry. The metal required for tungsten lamp filaments must be of an exceptional purity—far higher than that required for steel alloys—so that the method of refining involved a considerable amount of research and development work before it could be put into regular operation on a commercial scale. This was successfully accomplished, and the whole process of refining the ore and producing ductile tungsten filaments from the metal obtained has now been continuously in operation since the middle of 1915, and many millions of feet of wire have been made.

The British Thomson-Houston Co. not only takes care of its own requirements, but supplies filament for lamps made by a number of its licencees. It has sufficient capacity for supplying far more than the requirements of the lamp industry of Great Britain, if needs be.

Trusting that you may be able to find space for this letter in an early issue.—We are, &c.,

THE BRITISH THOMSON-HOUSTON CO., LTD.,
Patent Department.
Rugby, Dec. 20. JOHN GRAY.

FACTORY ELECTRIFICATION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I notice in your issue of November 30th a letter signed by E. W. Dorey criticising the sub-station equipment of the C.W.S., Manchester. It is obvious that Mr. Dorey is unacquainted with the reasons for the adoption of the scheme, or he would have written with more restraint. The buildings taking the supply cover a large area, and, with one or two exceptions, are wired on the old tree system of distribution for the low voltage of 105, and most of the wiring has been in many years. For several reasons it was out of the question to adopt the Corporation voltage of 400 volts direct, and as the existing generators were in good condition they were coupled direct to new motors, instead of scrapping them. The load varies from 5 to 100 per cent. of the maximum, and consequently the utilisation of smaller units makes a very elastic job, besides providing greater immunity from interruption of supply than would be the case with the two or three larger units suggested by Mr. Dorey. Further, it is intended, as circumstances permit and requirements demand, to re-wire the existing premises suitable for taking Corporation supply direct. This will, of course, be done piecemeal, so that the generators will one by one disappear, until ultimately they cease to exist. The motor part of the generators, with their starting panels, will as opportunity arises be transferred and re-used for driving purposes at several of the society's new factories or extensions. If the sets had been put in as large as Mr. Dorey recommends, it follows that the opportunity of re-using them could not be so [illegible] as will be the case with the smaller sets installed.

Mr. Dorey takes exception to the supposed large floor space occupied by the switchboard. I can assure him that no floor space is occupied that could have been put to any other purpose, as the equipment is "housed" in an existing room, and the small reduction of floor space by the amount of the reduced switchgear suggested by him, even if desirable, would not have served any useful purpose.

Without any knowledge of the terms of supply, Mr. Dorey suggests that the C.W.S. are getting against their interests by putting in smaller units and less efficient machines than the larger ones suggested by him. I do not propose to enlighten him on this matter. It would, however, be interesting to know if he expects efficiency from the larger set when working on only 10 per cent. of its rated load, which would have often been the case owing to the peculiar demand.

Mr. Dorey's knowledge of the inherent reasons for the adoption of the scheme is nil; therefore his criticism is not of much value.—I am, &c.,

Manchester, Dec. 22. R. L. [illegible]
Engineer, C.W.S.

Legal Intelligence.

Gabbott v. Jones.

At Liverpool County Court recently, His Honour Judge [illegible] had before him the adjourned case of [illegible], which involved a claim by the tenant of a house in Marion-road, Bootle, against his landlord for damages for alleged trespass, [illegible] and removal of the light wires, &c.

It was stated at the previous hearing that [illegible] tenants of the same landlord were interested in the case, disputes having arisen out of changed conditions in regard to the lighting of the houses, gas being substituted for electric light in September, 1915. Electricity had been suppied by landlord from an independent station at his brickworks in the neighbourhood, and the cost of the current had been included in the rent of the houses. When [illegible] and the electric supply was cut off by the landlord, disputes arose as to rent after the tenants became gas consumers at their own cost.

In the present case the tenant sought to claim for breach of agreement and trespass, but on the previously amended particulars of claim, his Honour ruled that the action was confined to a claim for trespass. On that issue His Honour intimated that he was prepared to decide against plaintiff, but he thought it was a matter in which a permanent settlement should be arrived at in an amicable way, and on his suggestion that a reduction of 4d. a week might meet the difficulty he adjourned the hearing for a week.

On the resumed hearing it was stated that nothing could be done in the way of coming to a settlement with plaintiff, though defendant was willing to accept His Honour's suggestion made at the last hearing. The Judge therefore gave judgment for defendant, with costs.

Workmen's Compensation.

The Court of Appeal (Lords Justices Swinfen Eady, Warrington and Scrutton) recently heard the appeal of respondent in the case of the Birmingham Railway Carriage & Wagon Co. v. Round, from the award of Judge Howard Smith, sitting at West Bromwich County Court.

Appellant, who was in the employment of applicants as an electrician's assistant, on Oct. 28, 1916, met with an admitted accident, which resulted in his right hand being crushed. The employers paid him half wages (16s. 7d. per week) down to May 23, 1917, when they filed an application to reduce the weekly payments by a lump sum payment. The County Court Judge, after hearing the medical evidence, found there was some partial earning incapacity of Round as a result of the accident; but that it was not permanent, and he assessed the compensation payable by the employers to him at £80, for which amount he made his award without making any order as to costs. From this decision Round now appealed, upon the ground that in the circumstances the County Court Judge should be assessed the compensation payable by the applicants to him upon the basis that as a result of the accident and the injuries he had sustained to his hand he was permanently partially incapacitated from earning the wages in the future which he would in ordinary course expect to earn as a skilled man at his trade.

At the conclusion of the legal arguments, their Lordship's held there was evidence upon which the learned County Court Judge could justify his award, and dismissed the appeal with costs.

Volunteer Notices.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

Headquarters: [illegible], W. 1.

Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.

Orders for the Week.

[illegible]

[illegible]

[illegible]
7.30.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]
open.

[illegible]

Patent Record.

APPLICATIONS FOR PATENTS.

*Note.—The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

November 7, 1917.

[illegible]

16,248 NOBBS. Electrically heated gloves.
16,261 EXLEY & LEITNER. Electric accumulators.
16,263 MCKENZIE, HOLLAND & WESTINGHOUSE POWER SIGNAL CO. (Union Switch & Signal Co.) Railway signalling, railway signalling systems and relays therefor.
16,263 MCKENZIE, HOLLAND & WESTINGHOUSE POWER SIGNAL CO. (Union Switch & Signal Co.) Railway signalling.
16,264 MCKENZIE, HOLLAND & WESTINGHOUSE POWER SIGNAL CO. (Union Switch & Signal Co.) Railway signalling systems and relays therefor.
16,263 B.T.-H. CO., WARETON & YOUNG. Magneto electric machines.
16,266 B.T.-H. CO., SALISBURY & YOUNG. Magneto electric machines.
[illegible]
16,267 B.T.-H. CO. & YOUNG. Magneto electric machines.
16,279 BROWN, BOVERI ET CIE. Regulating shunt dynamos. (11/11/16, Germany
16,286 ZIMMERMAN. Terminal connectors for electrical conductors.

November 8, 1917.

16,317 CURTIS. Controlling electric lighting of motor vehicles.
16,320 BOYD. Sparking plugs for explosion motors.
16,321 TRAVIS & WATSON. Device for closing orifices in roof and walls of electric furna through which electrodes pass.
16,339 BOLTON & WALKER. Deposition of metals by electrolysis.
16,354 B.T.-H. CO. & YOUNG. Magneto electric machines.
16,384 WOLF-BURCKHARDT. Metal vapour camps. (11/11/16, Germany.)
16,394 OLDHAM. Galvanic batteries.
16,398 GERKEN. Spark plugs.

November 9, 1917.

16,426 MCKENZIE, HOLLAND & WESTINGHOUSE POWER SIGNAL CO. (Union Switch & Signal Co.) Railway signalling and h.f. selective devices therefor.
16,434 LE THERMO PATENTS (LTD.), GREENHALGH & LONGBOTTOM. Dynamo-electric machinery.
16,439 CALLENDER'S CABLE & CONSTRUCTION CO. & HALL. Aerodrome lighting.
16,465 BARON. Sparking plug.
16,475 IGRANIC ELECTRIC CO., WRIGHT & CURTIS. Electrical heating apparatus for fabrics, &c.
16,477 HOLMQUIST. Electrically heated gloves.

November 10, 1917.

16,490 ELECTRIC & ORDNANCE ACCESSORIES CO. Starters for electric motors
16,499 LANGRESH. Starters for electric motors.
[illegible]
16,516 TOFIELD. Jointed arms or brackets for electric or gas lamps.
16,517 ELECTRIC CONTROL (LTD.) & ELEFSEN. Alternating current relays.
16,532 EGGINTON & LUCAS. Electric vehicle, &c., lamps.

November 12, 1917.

16,561 SMITH. Electric lamp switch.
16,568 COPLANS. Portable electic torches, &c.
16,581 COW. Maximum demand controller and load indicator.
16,591 FUTERS. Electric detonating fuses.

November 13, 1917.

[illegible] Manufacture of electric cables.
[illegible] Measuring instruments.
16,645 LEVIN. [illegible] rators. (18/11/16, U.S.)
[illegible]

[illegible] Electric cigar lighting, &c.
[illegible]
[illegible] Electric lamp holders.
[illegible]
[illegible] methods and apparatus. (25/11/16, U.S.)
[illegible] netic clutches.
[illegible] stribution.
[illegible] ro-radiant energy. (28/9/16, U.S.)
[illegible]
[illegible] signals.
[illegible]

Commercial Topics.

Siemens Brothers Control.

It is announced by the "Daily Mail" that after long negotiations a contract has been entered into for the sale of the German owned shares in Messrs. Siemens Bros. & Co. and Siemens Dynamo Works to a syndicate consisting of British-born subjects. It is their intention to carry on and expand the business, which has been supported by Government war contracts.

At the outbreak of war the family of Siemens held 70,000 shares out of 120,000 of £5 each. The control was in the hands of Siemens & Halske, of Berlin, and dividends were being paid in Berlin at the rate of £35,000 a year.

It is reported that the purchasers of the shares are Messrs. Birch, Crisp & Co., and Messrs. Cory Bros.

* * * *

Trade After the War.

Last week the President of the Board of Trade received a deputation from the Association of Chambers of Commerce of the United Kingdom in order to point out certain objections to the Imports and Exports (Temporary Control) Bill.

SIR ALGERNON FIRTH (the president of the Association) stated that their objections were based on the fear that the control of industry after the war by the Government Departments which are now interfering with it might continue too long, and the apprehension that a man might not be able to conduct his business on his former lines of doing as he liked and selling where he pleased. The Chambers of Commerce wanted safeguarding against undue interference in their industries.

In his reply, Sir ALBERT H. STANLEY, M.P., said that the Bill did not consider any questions of policy after the war, as no one could foresee what the policy of the Government would be at that time. The Government now controlled practically the entire trade of the country, and when the war came to an end, so complete a transformation would take place that it would be possible immediately to bring that machine to a stop. The Board had given the matter most careful consideration, and, in their view, just as the machine had been gradually wound up, so must it be gradually unwound. Their desire was that the control should be brought to an end at the earliest possible moment. He did not accept the view that, owing to the magnitude and length of the war, it would take a very long time before industry could re-establish itself and go on unfettered. The return to a condition which would admit, if not of a total relaxation of control, certainly of a very considerable relaxation of it, would not take such a long time as some people imagined. After careful consideration the Board had inserted a period of three years in the Bill, without contemplating for a single moment that anything approaching the restrictions in the aggregate, as they would exist at the time when the war came to an end, would be continued. He trusted that they would be able to arrive at some period which would give general satisfaction. They were not wedded definitely to the period of three years. Tonnage was a serious proposition, and would be so, especially when the war ended. The question of the administration of the control under the Bill had been raised, and on that point the Board had every possible desire that the powers should be administered with the least possible inconvenience and as fairly as possible to those affected. We had given a pledge that we would assist to the fullest extent in re-establishing Belgium, Serbia and France after the war, and it was necessary that there should be legislative authority such as the Bill conferred.

* * * *

Control of Tar and Naphtha.

The Minister of Munitions has made an Order under which no person shall be permitted until further notice to purchase any tar (whether crude or dehydrated) except under licence issued by or under his authority. Licences will not, however, be required by a tar distiller, provided that the whole quantity purchased is distilled to pitch by such distiller, or by any person for the purchase of tar in quantities not exceeding 10 gallons, provided that the total quantity purchased by any one person during [illegible] month does not exceed 50 gallons.

From the 15th inst. until further notice no person manufacturing or producing tar shall burn or consume it for fuel, steam raising or heating purposes, nor use it for any other purpose except in accordance with the terms and conditions of a licence.

The Minister of Munitions has also made an Order providing that from [illegible] 10 no person shall until further notice supply to any person [illegible] delivery of any crude solvent naphtha, solvent naphtha [illegible] naphtha except under a licence issued by the Minister of Munitions. All applications in reference to the Order should be addressed to the Director of Raw Materials Supply, Ministry of Munitions, Department of Explosives Supply, Storey's Gate, Westminster, S.W. 1.

* * * *

Chemical Trades Reorganisation.

The Committee appointed to consider the question of the organisation of the chemical trades has presented a report to the Minister of Reconstruction.

It is stated that numerous difficult problems and questions are likely to arise, and close collaboration between the Minister of Reconstruction and representatives of the trade is essential. As the most representative body the Committee select the Association of British Chemical Manufacturers. This, however, does not adequately represent certain branches of the industry—*i.e.*, fertiliser manufacturers, sulphate of ammonia manufacturers, tar distillers, explosive manufacturers, &c. The Committee are, therefore, of opinion that in dealing with the chemical trade the Minister could properly act in collaboration with the Association of British Chemical Manufacturers. If, however, it should be necessary to take advice concerning a branch of the trade not adequately represented in this association, the appropriate association could be taken into consultation. The Committee suggest the appointment to the Ministry of Reconstruction of a scientific man of good standing, who would command the respect and confidence of the trade, together with the necessary staff. This section, working in conjunction with the standing committee previously mentioned, would, in our opinion, provide you with an adequate organisation for dealing with such questions connected with the chemical trade which might come within your purview. The following would represent some of the duties of this section :

"1. To ascertain, with the assistance of the Standing Committee, the chief problems which are likely to arise in the process of reconstruction after the war and the best means of dealing with them.

"2. To survey generally the chemical trade, both at home and abroad, and, in consultation with the Standing Committee, to afford advice for the broadening and improvement of the chemical trade of this country.

"3. To collect and disseminate information on, and statistics of, the chemical trade.

"4. To collect and collate as much information as is available on the work which has been done during the present war, which would no doubt be of great interest and assistance to the chemical trade as a whole."

The Committee conclude : "In the foregoing report we have confined our recommendations within the narrow limits defined by the forms of reference, which speak only of 'Chemical Trade.' If, however, for that expression were substituted 'the National Chemical Industry,' a much broader purview would be involved, and specific reference would be necessary to existing organisations other than those specifically founded for 'trade' purposes.

* * * *

An Imperial Bank of Industry.

In a report recently issued by the Committee on Banking of the British Empire Producers' Organisation, the creation of an Imperial Bank of Industry with State guarantees is recommended.

The object of the Bank would be to afford readier financial support throughout the United Kingdom and the Overseas Dominions and Colonies for producers and manufacturers, and it is intended that there shall be no opening for German financial intrigue in obtaining control of any group of industry. The available capital is to be provided in the shape of debentures and deposits with State guarantee. Further capital will also be accumulated by the funding of profits, ... a small bonus to debenture holders ... all surplus will remain in the bank. ... [illegible] ... £2,000,000 ... Australia, £2,000,000 each ... £1,000,000 ... [illegible]

Electricity Supply.

Extensions.

Belfast. [illegible]

Leeds. [illegible]

Swansea. [illegible] £12,000 [illegible]

Southampton. Application to borrow £20,000 for additional generating plant and mains has been made to the Local Government Board.

Watford. Authority to raise a loan of £750 for electric supply purposes has been applied for by the Urban Council.

Wolverhampton. The L.G. Board has been asked to sanction a loan of £1,800, being the difference between the estimated cost of additional converter plant and the estimated amount to be received on account from the sale of the ... [illegible] ... cating sets.

General.

Acton.—The Council have decided to obtain counsel's opinion upon the legality of the recent increase of charges for electric current made by the Metropolitan Electric Supply Co.

Ballymoney (Ireland).—The Urban Council have invited Mr. J. McClenaghan, of the Portstewart Electric Supply Co., and the Ballymoney Gas Co. to submit proposals for lighting the town.

Braintree.—Applications for provisional electric lighting orders are being made by the Urban Council and by the Crittall Mfg. Co. There is, however, some opposition to the Council's application.

Cork.—The Corporation have asked Mr. J. P. Tierney to report on the local electricity supply works.

Dock Lighting.—The Mersey Docks and Harbour Board are considering a scheme for the electric lighting of the whole of the dock estate.

Increased Charges for Electrical Energy.—The charges for current are being increased at the following places.

Manchester electricity department is increasing its charges by 20 per cent.

At Hornsey the charges are to be increased to 40 per cent. over pre-war charges.

Hebden Bridge Council is increasing its charges by $8\frac{1}{2}$ per cent. for lighting and 20 per cent. for power.

At Lancaster an increase of 25 per cent. is to be made on Jan. 1.

Loughborough Council is increasing the prices of current for power by 10 per cent.

Stoke-on-Trent is increasing its charges by $6\frac{2}{3}$ per cent., making 40 per cent. over pre-war rates.

Shipley Council is increasing its power rate from $1\frac{3}{4}$d. to 2d. per unit, with 25 per cent. on the sliding scale, making 50 per cent. over pre-war charges, and the lighting rate is increased from $4\frac{3}{4}$d. to 5d.

Kirkcaldy ... charges are being increased by ... making 50 per cent. in all.

Islington (London) Council is increasing by 50 per cent. the charges [illegible]

At Darwen the prices of current for power and lighting have been increased by 10 per cent.

At [illegible] ... are also being made in prepayment charges.

[illegible] ... from 1d. to 2d. per week.

[illegible] ... cent. over pre-war rates.

[illegible] ... in all.

The charges for town lighting at Colchester are being increased by [illegible]

[illegible]

Newport (Mon.) [illegible]

Restrictions on Cable Laying. [illegible]

cable alone, or, at the worst, to the cost of all material, cable, duct, boxes, &c., that is to say, excluding the cost of all labour, supervision and establishment charges from such £10 limit, for the reason that work carried out under the conditions you mention, will no doubt in every undertaking be carried out by the regular maintenance staff, that is to say, no further call upon the labour market would be made in the execution of such work."

On Dec. 28 Mr. Arnold B. Gridley replied that "the £10 limit does not necessarily prevent the connection of a consumer, but it necessitates an application to this department for sanction. In every case where the limit exceeds £10 and electrical undertakers consider the circumstances justify their submitting an application to me for decision, the same will always receive every consideration. In the meantime, however, I am willing that the £10 shall exclude labour, so long as no outside labour is employed, and you may advise your members to this effect. It was not intended that the limit should include supervision and establishment charges."

On Dec. 31, Harrogate Electricity Committee unanimously passed a resolution protesting against the demand for a monthly return of business, as it entailed considerable extra work upon a depleted staff.

Electric Traction.

Electric Vehicle Committee of Great Britain.—The Motor Trades Association will in future be represented on this Committee by the president, Mr. Arthur Goodwin (of Messrs. Vandervell & Co.), while the Association of British Motor and Allied Manufacturers has nominated its secretary, Mr. Horace Wyatt, as its representative. Mr. J. P. Kemp, of Birmingham, has been co-opted upon the Committee specially to represent the interests of electric vehicle agents.

Halifax.—The Tramways Committee recommend an increase of 50 per cent. in the tramway fares and the abolition of transfer tickets.

Lancaster.—The Corporation have authorised the borrowing of £6,000 for the purchase of electric omnibuses.

Ald. Preston, chairman of the Tramways Committee, explained that they were being pressed to put more electric 'buses on the road. It did not, however, mean that they had to spend the whole of the £6,000 at once on 'buses.

Southend.—Messrs. Ransomes, Sims & Jefferies, the contractors for the supply of electric vehicles for dust collection, have increased the amount of their quotation for the supply of the vehicles from £932 to £966 each.

Standardisation of Tramway Overhead Construction.—A meeting of the Sub-Committee of the Municipal Tramways Association has been held in Leeds upon the question of "Standardisation of Overhead Construction."

The object to be attained is to standardise everything possible, so that after the war tramway undertakings will be able to get good deliveries and reasonable prices. At present there are between 50 and 100 different forms and types of one fitting, each engineer having his own ideas and manufacturers having to hold a stock of each. The tramways manager of Bradford Corporation has been elected chairman of the Sub-Committee.

Tramway Workers' Wages.—The tramway employees of 19 local authorities in Lancashire and Cheshire are claiming a further advance in wages of 10s. a week. This demand is in addition to the recent advance of 12s. for male and 9s. for female workers.

Wigan Tramcar Accident.—An inquest was held on Friday upon the two victims of the recent accident to a Corporation tramcar on the [illegible].

[illegible]

Miscellaneous.

Electric Power in the U.S.A.—In order to ensure an adequate supply of electric power for the concerns engaged in war work at Niagara Falls and Canada, the Government has requisitioned the electric power produced by various power companies at the Falls.

Presentation.—Mr. Robert Hunter, who has been for nearly 19 years [illegible] engineer in Aberdeen Corporation electricity department, having tendered his resignation.

On the [illegible], the staff and employees met at the Works in order to [illegible] and God-speed in his new sphere.

[illegible] (Mr. J. A. Bell) occupied the chair, and referred [illegible] to the fact that Mr. Hunter had decided to sever his connection with the department. During the time he had been in Aberdeen he had acted as his right-hand man, and now that he was going they would all miss him very much. The sterling quality of the work, however, which he had undertaken during these years would remain behind to remind them—if that were necessary—of his personality and his executive ability as an engineer, while his varied experience, his sound technical knowledge and exceptional force of character would stand him in good stead wherever he went. He joined with the other speakers—Messrs. Clark, Burnett, McKay, Ross, Fyfe and Downie—in wishing him every success. In the name of those present he asked him to accept from the staff and employees a silver matchbox and a gold albert as a token of esteem.

Mr. Hunter feelingly replied, spoke of his regret at parting with so many good friends and warmly thanked them for their handsome gift.

Pyrites Mined in the United Kingdom.—The Ministry of Munitions is prepared during the period of hostilities to purchase iron pyrites mined in the United Kingdom.

The pyrites must contain not less than 37½ per cent. of sulphur, and not over 1 per cent. of arsenic. The price payable will be 35s. per ton of pyrites f.o.r. for quantities of not less than one truck load. Particulars from the Department of Explosives Supplies, Storey's-gate, Westminster, London, S.W. 1.

Science Museum, South Kensington.—This museum, which has been closed nearly two years, was re-opened for students on Tuesday.

United States Railways.—The U.S.A. Government assumed control of the railroads in the United States on Friday last and Mr. McAdoo has been appointed Director-General of Railways.

President Wilson's Proclamation applies to "each and every system of transportation and the appurtenances thereof located wholly or in part within the boundaries of the Continental United States and consisting of railroads, owned or controlled systems, coastwise and inland transportation, whether operated by steam or electric power, including also terminals, terminal companies, terminal associations, sleeping parlour and private cars, private car lines, elevators, telegraph and telephone lines, &c., commonly used or operated as rail or combined rail and water systems of transportation."

Street railways are not, however, affected. The direct management of the railroads will remain in the hands of the present railroad officials. The Railroads War Board will continue to direct the actual operations under Mr. McAdoo's supervision.

Tenders Invited and Accepted.

Storage Battery, &c.

TIPPERARY Guardians require tenders by 2 p.m. Jan. 11 for the supply of a new Battery in connection with their electric lighting plant and for overhauling a gas engine. Specifications from Mr. J. P. Tierney, 44, Kildare-street, Dublin.

Rotary or Motor Converter.

MANCHESTER Electricity Committee require tenders by 10 a.m. Jan. 16 for the supply and erection of a rotary converter or motor converter plant. Specifications from Mr. F. E. Hughes, Town Hall, Manchester.

Electrical and General Stores.

HAMPSTEAD (London) Council require tenders by 4 p.m. Jan. 17 for one year's supply of electrical and engineer's stores, oils, ironmongery, pitch, &c. Forms and tender may be obtained at the Town Hall.

Telephone Service.

ROSARIO (Argentina) Municipality recently invited tenders, which are to be opened on Feb. 23, for the provision of a telephonic service within the district of the municipality.

POPLAR (LONDON).—The Borough Council has accepted the following tenders:

Bruce Peebles & Co., supply and erection of one 1,000 kw. rotary converter, £3,850; William Boby, alteration to water softening plant, etc.

Government Contracts.—The following tenders were accepted by the British Government Departments during November:

[illegible] Auto. Vacuum Kettler Co., Hooper's [illegible] Johnson & [illegible] Stevens (Ltd.) [illegible] Austin Motor Co., W. H. Dorman & Co., Electric Construction Co., Smart & Brown, and J. Hughes & Sons, [illegible] Electricity Corpn., and [illegible]

India Office.—J. Stone & Co., dynamos.

H.M. Office of Works.—Automatic Telephone Mfg. Co., British L. M. Ericsson Mfg. Co., [illegible] and Western Electric Co., telephone apparatus; Siemens Bros. & Co. and Western Electric Co., testing apparatus; [illegible] Cable Co., Hackbridge [illegible] India Rubber, Gutta Percha & Telegraph [illegible] New Gutta Percha Co., telegraph cable; Connolly Bros., telephone cable; Siemens Bros. & Co., dry cells and Leclanché cells, telephone [illegible] mouthpieces; India Rubber, Gutta Percha & Telegraph Works Co., [illegible], Guest, Keen & Nettlefolds, insulator spindles; T. H. Haagen, Son & Co., cable suspenders; Western [illegible] Walter & A[illegible], telephone terminals; T. Bolton & Sons, British Insulated & Helsby Cables, Shropshire Iron Co., and F. Smith & Co. (Inc. in London Electric Wire Co. & Smiths), bronze wire; C. Macintosh & Co., enamelled and [illegible] Johnson & Nephew, Rylands Bros., and Whitecross Co., v.i. wire; Union Cable Co., v.i.r. wire.

Appointments Vacant and Filled.

Two shift engineers are required for the Hereford electricity works Salary £140 per annum. Applications to the engineer and manager. Mr. W. T. Kerr. *See advertisement.*

A representative is required by steel manufacturers. Salary £4 per week, plus commission and expenses. *See an advertisement.*

A meter test-room attendant is required at electricity works; must be conversant with a.c. supply and Aron clockwork meters. Salary £140 per annum and [illegible]. *See advertisement.*

Applications are invited for the post of head of the electrical engineering department of the Loughborough Technical Institute. Salary £220 per annum with £30 [illegible]. Applications by Jan. 19.

Applications are invited for the post of Head of the Department of electrical engineering and physics of the Victoria Jubilee Technical Institute, Bombay. Salary Rs. 700. Applications by March 31, 1918, to Mr. D. E. Wacha, Honorary Secretary of Board of Trustees, Byculla, Bombay, India.

Ilford Urban Council have confirmed the appointment of W. Greenwood as temporary third engineer in charge, at £150 per annum and war bonus.

Liquidations.

New Era Signs (Ltd.) is being wound up voluntarily, and Mr. W. G. Olliffe, 7, Leadenhall-street, London, E.C. 3, has been appointed liquidator. Claims to Mr. Olliffe by Jan. 31. Meeting of creditors at the offices of Messrs. H. & P. Spottiswoode, 30, Norfolk-street, W.C. 2, on Jan. 8.

The National Provincial Electricity Corpn. (Ltd.) is being wound up voluntarily, and Mr. S. Gillatt, Balfour House, Finsbury-pavement, London, E.C., has been appointed liquidator.

Claims against the Resisto Electrical Mfg. Co. (Ltd.) are to be sent by Jan. 18 to the liquidator, Mr. De Westley Layton, Thorners chambers, Ingram-court, London, E.C. 2.

Mr. Charles Turner, 155, Norfolk-street, Sheffield, has been appointed (with a committee of inspection) as liquidator of Best's Safety Lamps (Ltd.), Providence Works, Park lane, Leeds.

Business Items.

Plant for Sale. The City of Leeds electricity department have for disposal some engines, alternators and condensing plant, which have been discarded for larger units. Particulars are given in an advertisement. Offers should be addressed to the Manager, electricity dept., 1, Whitehall-road, Leeds.

Calendars, &c.—We have received from the General Electric Co. a refill of daily slips for 1918 for their daily reminder calendar.

Mr. A. Joseph, metal merchant, of Earl-street, London, S.E. 1, sends us a perpetual calendar with [illegible]. Customers who have not received a copy should apply to the firm.

Companies' Meetings and Reports.

BRITISH COALITE (LTD.)—[illegible]

Germany in the utilisation of national wealth and resources that even the most hide-bound [illegible] probably now realised that the old laissez faire policy must [illegible] vigour and determination in every department of [illegible].

BRITISH COLUMBIA ELECTRIC RAILWAY CO. (LTD.)—The report for the year ended June 30 last states [illegible] renewals maintenance absorbs £101,450, [illegible] £15,000 and [illegible] to capital amortisation fund £2,762. [illegible] £160,844, to which is added £6,860 brought forward and £44,000 transferred from reserve. [illegible] for the year required £132,671 and dividends already paid on five per cent. cumulative perpetual preference stock for the year absorbs £72,000, leaving £7,033 to carry forward. The report of the Commissioner appointed to investigate into the question of the transportation is stated to justify the past policy and operations of the Company. Negotiations are being carried on in British Columbia with a view to making arrangements for giving effect to the Commissioner's recommendations. For the first four months of the current year the gross earnings show an increase of approximately $146,817. This has, however, been more than absorbed by increased expenses, and net earnings show an approximate decrease of $2,648. Owing to the uncertain outlook the directors feel that it is prudent to postpone the payment of [illegible] five per cent. cumulative perpetual preference stock.

BURMAH ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.)—The profit for year to July 31 last was £9,498, of which £3,000 has been transferred to reserve for depreciation and £500 to reserve for depreciation of investments. Including £502 brought forward, £6,000 is available. A dividend of 6 per cent. on the preference shares has been declared, against 5 per cent. each of three preceding years (leaving arrears of 53 per cent.), and carrying forward £500.

CORDOBA LIGHT, POWER & TRACTION CO. (LTD.)—The report for the year to Sept. 30 last states that during the whole year there was deficiency in the supply of water from the San Roque Lake, and over 25 per cent. of the energy required to supply the Company's customers and tramways was generated by steam. At times it was necessary to curtail the supply of current to consumers, and in consequence of this and of a strike on the tramways, the takings of the subsidiary companies were reduced by about £3,500, while the extra expenses due to steam operation alone were over £34,000, or £11,000 more than the previous year. As a result the profits were not sufficient to meet all the charges, and there was a loss of £17,721. This has been deducted from the amount brought forward, leaving £8,630, which will be carried forward.

At the meeting on Monday Sir Geo. Touche said that perhaps no companies had been hit worse in the war than those operating abroad in countries where it was necessary to import fuel. Had there been anything approaching a normal rainfall they would have been, not altogether but in a large measure, independent of the fuel problem, for their hydraulic stations would have supplied their needs. The tragedy of the position was that during the last two years, when the cost of fuel was without parallel, the failure of the rains and the water power had also been without parallel. But for the water failure last year and the expenditure of £35,000 on the steam plant, there would have been a surplus of about £17,000 instead of a loss of about £18,000, and this notwithstanding the depression in the Argentine, the paralysis of the transport facilities of the country for a whole month owing to the railway strike, and the general financial stringency. [illegible]

INDIA RUBBER, GUTTA PERCHA & TELEGRAPH WORKS CO (LTD.)—[illegible]

in peace time. The foreign branches on the whole had done well, and Persan had made a good profit, in spite of great difficulties in regard to [illegible] and [illegible]. They had lately been in correspondence with the Inland Revenue with regard to this duty on the profits on the year ended Sept. 30.1916, and had accepted their assessment. As long as the war lasted they hoped to have plenty of Government work, but when peace was declared an anxious period would be in store for all those firms who had lost much of their usual trade through the making of munitions. They had set aside a certain amount for those troublous days, but if, as might well happen, it should prove insufficient, they must hope that the Government would come to the assistance of themselves and other firms who had been put to disadvantage by the performance of national work. The extra profits from war work would assuredly have been sufficient to see them through all their future difficulties if they were not nearly all to be taken from them. He concluded by referring to the excellent work done under most trying circumstances by their much depleted staff.

VERA CRUZ ELECTRIC LIGHT, POWER & TRACTION (LTD.)—The chairman (Mr. Vincent W. Yorke), who presided over the meeting on the 20th inst., said that in February last, owing to the absence of the accounts for 1915, their meeting had to be adjourned for six months. As the accounts for 1916 were nearing completion in August the meeting was adjourned to consider the reports for the two years. The period covered by the accounts had been the most difficult years in their history, and the net results showed a loss of only £702. The net earnings had been converted into Mexican gold dollars, and it was not possible to compare the figures with those for 1914, which were shown in Mexican currency. The net earnings for 1916 were some $12,500 higher than in 1915. Provision had been made in Mexico for all doubtful accounts, and after paying all expenses, debenture interest, &c., and providing for exchange losses, the credit balance on Dec. 31, 1916, was £13,314. The company continued to receive its power from the hydro-electric plant of the Puebla Tramway Light and Power Co., and except for intervals of short duration, when that company's transmission line had been out of service on account of the activity of rebels in the district, the supply had been continuous. In 1915 out of 6¼ million units consumed only 354,000 were generated by their own plant, and in 1916 out of practically the same consumption their own plant generated 415,000. The steam turbine plant which was installed temporarily pending the completion of the Puebla Company's transmission line, had been disposed of on satisfactory terms. Many improvements have been made in the tramway tracks; new car barns, offices and shops were in the course of construction, and many new ornamental posts for street lighting had been installed. Although the conditions of the country were by no means settled, the outlook for the current year was extremely satisfactory. All sections of their business showed improved results, and figures were given in support of this statement. The financial situation in Mexico still gave cause for anxiety, although in consequence of the change in currency at the end of last year the actual earnings of the company were on a gold basis. The net earnings this year had reached the substantial sum of approximately $460,000 Mexican gold, or $47,000 [illegible] September. He was not without hope that when the accounts for this year were completed it might be possible to [illegible] resumption of dividends on the ordinary shares.

New Companies.

BERRY'S ELECTRIC LTD. (149,161.)—Private company. [illegible]

SURBITON CONTRACT CO. (LTD.) (149,128.)—Private company. [illegible]

City Notes.

[illegible] TRACTION, LIGHT & POWER CO. (LTD.) [illegible]

[illegible] TELEPHONE CO. (LTD.) [illegible]

GENERAL ELECTRIC CO. [illegible]

VICTORIA FALLS & TRANSVAAL POWER CO. (LTD.) [illegible]

[illegible] TELEGRAPH CO. (LTD.) [illegible]

[illegible] WEST RIDING ELECTRIC TRAMWAYS CO. (LTD.) [illegible]

The Round Table.

By "kVA."

EVENT OF THE WEEK.—The sale of Siemens.

* * *

To Round Table readers at home and abroad I wish "all the best in the New Year" and may it bring to the Allies an honourable peace.

* * * *

Mr. Sedgwick Barnard's poem on DORA in "Chloride Chronicles," the house organ of the Chloride Electrical Storage Co., is too good to miss, but I am compelled to cut her in half, owing to space shortage. (Most of us would like to dismember her I think.)

D.O.R.A. THE DESPOT.

(SHE WHO *MUST* BE OBEYED.)

Come, listen, good masters, I'll sing you a song
Of Dora, the despot who never does wrong!
She lives up in London—or so I've been told,
And Britain's her portion, to have and to hold.

She opens your letters, she alters your trains,
She acts like a goat with a pudding for brains,
She issues new orders and cancels them, too,
Then sets up Departments to muddle them through.

She doubles your taxes, then tells you to save,
She mothers your steps from the school to the grave,
She plies you with questions and forms by the score,
And if you don't answer she sends you some more.

She orders your breakfast; she schedules your tea;
She tells you exactly how hungry to be.
She keeps a Controller to ration your prog,
And if you start hoarding she dubs you a hog.

She sells you potatoes at maximum price,
But throws in a bag of official advice,
She sets you to dig and to plant and to sow,
Then says it's your fault if your turnips don't grow.

Supposing you travel for business or health,
She'll certainly think you're escaping by stealth.
There's no one allowed to set foot on the quay,
For Dora's most jealous in sight of the sea.

A. S. B. in *Chloride Chronicles.*

(*To be concluded.*)

* * * *

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, January 1, 1881.]

TRANSVAAL.—The telegraph wires beyond Heidelberg have been cut by the Boers. Mr. Ilbery, the inspector of telegraphs for that district, made his escape, and returned to Standerton. The two [illegible] were taken prisoner.

HELIOGRAPHIC.—A number of the heliographs lately brought back by troops from South Africa will be sent out at once to the Transvaal, also some improved signalling apparatus, and a number of mounted and dismounted signalmen.

ELECTRIC LIGHTING AND STREET TRAFFIC.—The other evening a [illegible] knocked down and severely injured a foot passenger in [illegible] street, London, and the driver, as usual, made off as [illegible] would take him. A police constable, however, [illegible] for a short distance, and, [illegible] the station, where the [illegible] brilliantly illuminates the street, was able to take the [illegible] of the offending vehicle. [illegible]

[illegible] MINERALS.—[illegible] of the mineral output of [illegible] as follows: [illegible] 21,063 cwt. in 1915, [illegible] 168,032 [illegible] tons (8,010 tons), wolfram 39,091 cwt. (39,132 cwt.). There were also increases in iron ore, magnesite, [illegible] and bauxite. Molybdenite (8 cwt.) [illegible] appear in the records for the first time.

THE ELECTRICIAN:

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CONTENTS.

Notes.

Electric Power for Steel Works.

FROM one cause or another we have found it necessary to defer giving an abstract of Mr. A. H. MARSHALL's address to the Newcastle Local Section of the Institution of Electrical Engineers until our present issue. This address exhibits the distinguishing feature that it does not deal with progress, nor does it refer to the effects of war. In all probability our readers will feel that this is an advantage, and will be pleased to gain some information as to the possibilities of obtaining electric power from coke ovens and steel works through the surplus heat that is available. That a combination of coke ovens and steel works may lead to a highly economical arrangement is now pretty well known. Although the advantages of this combination have not been thoroughly realised in the past, there is certainly a tendency at the present day to bring these two classes of work together. By so doing, the amount of surplus heat available from the coke ovens becomes much less because it is utilised in the steel works, but even so a surplus remains. From Mr. MARSHALL's address it appears that this surplus may be very large. We are not able to check his figures, but we were under the impression, obtained from other statements that have been published, that the power is not so great as is shown by the figures now given. Be that as it may, the fact remains that there is a considerable surplus power, but it is necessarily scattered over certain districts; consequently, it cannot be so effectively utilised as would be the case if it were grouped in one small area. Nevertheless, such power can be put to a very useful purpose by means of waste heat stations such as are at present in operation, all supplying power into a common network. If such a network is sufficiently large the somewhat intermittent character of the supply becomes relatively unimportant. In fact, the power when available can be absorbed by the network, and if, on the other hand, excess power is at times required by a steel works from an outside source, such power can be supplied from the network, and at efficient working distances."

Public Information on Military Matters.

WE recently referred to the useful step taken by the Naval authorities in the United States in issuing a short summary of the chief problems involved in countering the efforts of submarines, in which the lines of possible inventions were narrowed down, and some common misconceptions in this direction removed. It seems a good course for the authorities occasionally to take the public into their confidence on such matters, when they can do so without giving information to the enemy. Otherwise inventors and scientific workers outside the narrow circles immediately associated with military or naval work are naturally at sea, waste their time on impracticable suggestions, and suffer discouragement. While recognising the need for secrecy on essential points, we think that authorities have sometimes ignored the other aspect of the matter, and by needless reticence have rather discouraged outside help. Now again we notice, in the "Electrical Review and Western Electrician," another instance of the more enterprising attitude taken up on such matters in the United States. At the recent meeting of the New York Electrical Society and the Engineers' Club an address was given by Lieut.-Colonel IVOR THORD-GRAY on "Some Phases of Trench Warfare," and this was followed by a contribution by Capt. P. CORCORAN on "Electrical Communications in Modern Warfare." Both speakers had first hand knowledge of conditions at the front, and their suggestions were naturally much appreciated by the audience. We think that informal discussions of this kind between officers and electrical and engineering bodies in this country would often be fruitful. At present there is a gap. Officers at the front have not the leisure to devise improvements; engineers at home with opportunities to do so hear little of the problems with which the officers have to contend. Greater freedom of discussion on points of common interest might yield distinctly useful results.

Sheffield and Rotherham.

WE are glad to note that a Joint Sub-Committee of the Sheffield and Rotherham Electricity Committees have considered the supply of electricity to Sheffield, Rotherham and the surrounding district, and have approved a linking-up scheme for the interchange of current. [illegible] of 20,000-25,000 kw. [illegible] and the cost of cables and transformers is estimated to be [illegible], the cost of the total scheme being £1,000,000. From the information to hand it is not clear just what is involved. It is evident, however, that the two local authorities have taken to heart the desire of the Government that there should generally be greater co-operation. Although there may be some advantages in towns some little distance apart having separate supplies, it is [illegible]

[illegible] and, therefore, the cheaper the supply to the consumer [illegible] though the coal costs may not be materially [illegible]

Private Plant at Collieries.

An interesting Paper was read by Mr. A. C. Nelson recently, of which an abstract appears on another page, giving particulars of installations at Wallsend and Hebburn. We are glad to note that the author is emphatically in favour of taking a supply from an outside authority rather than laying down private plant. He very rightly points out that in determining the costs of a private plant errors are very apt to be made in its favour. Depreciation and maintenance charges are underrated, repairs are not taken at their full value or upon all the plant involved, and interest on coals in bunkers is forgotten. Further, the time that the engineers give to the isolated plant must be taken from other work on which they are naturally more efficient, and the skilled attention required in connection with power generation can never be given in the case of a private plant to the extent which it is of necessity given by a supply authority. Mr. Nelson expresses the opinion that even where waste heat is available it is best for such heat to be utilised by a supply company, some suitable arrangement being made for the supply of current to the colliery. It is gratifying to see Mr. Nelson's statement, that where electrification has been carried out in his experience, comparative prices and running cost between up-to-date steam plant and electric power have shown in most cases that the electrical plant has the advantage.

An Interesting Transmission Cable.—For the transmission of electric energy from the Trollhättan power station to [illegible] on the west coast of Sweden, it is stated in "Engineering," a cable has just been laid across the Gullmar Firth. The cable is intended for transmission of energy at 20,000 volts, and it is stated that it is the first time a cable of such a weight (17 kg. per metre = 34 lb. per yard) and of such a dimension (diameter 74 mm. = 2·9 in.) has been manufactured in one length; it is 1,104 m. (3,622 ft.) long and has been lowered to a depth of 120 m. (394 ft.), which, it is claimed, is the greatest depth to which a high-voltage transmission cable so far has been lowered.

First Steel Electric Steel-melting Furnace in South Africa.—The shortage of many other materials is affecting the mining companies in various ways, and in some instances leading to new applications of electric power. For example, a recent issue of the Journal of the "Transactions" of the South African Institute of Electrical Engineers contains a Paper by W. Buchanan and G. H. Stanley, describing what is stated to be the first electric steel-melting furnace in South Africa. The furnace was rendered necessary by the great [illegible] of the mining industry for stamp battery shoes and dies which can only be met with difficulty owing to import restrictions. A regular supply of material of the order of [illegible] tons per annum is required, and arrangements are now being made to [illegible] by means of the new electric furnace [illegible] accumulations of scrap shoes and dies. The furnace was [illegible] 1917, the output [illegible] about [illegible] per month.

The Sources and Uses of Graphite.—[illegible]

Lighting in the Clothing and Textile Industry.—A recent article by C. E. Clewell in the "Electrical World" summarises some investigations conducted by the United States Public Health Service into the conditions prevalent in the clothing industry in New York. This inquiry showed that over 50 per cent. of the work-rooms visited were inadequately lighted. A common defect was glare, owing to imperfect screening devices. On 131 finishing tables, for example, employing 610 finishers, glare effects were observed in the case of nearly 98 per cent. of the artificial sources used. The table-illumination was considered inadequate when it fell below 5 foot-candles. Some experiments quoted by the author showed that the reflecting power of the material is directly connected with the illumination necessary to make the threads visible, the product of these two factors being almost constant. With very dark materials as much as 10-15 foot-candles was needed. Another important circumstance in this class of industry is the relatively poor facilities for admission of natural light. In all but the highest floors artificial illumination is necessary during normal working hours.

rendering it serviceable for furnace work. It can also be applied to form a useful protective paint, when mixed in suitable proportions with oil, being very uniform, adhesive and durable and impermeable to air. It has been adapted for purposes of lubrication with excellent results and forms a useful constituent for electrodes for arc lamps and electric furnaces, for brushes and in various special metallurgical processes.

Uses of Electricity in Mines.—Some interesting electrical investigations appear to have been recently conducted by the United States Bureau of Mines. The Year Book of the Bureau contains some information on a series of researches undertaken with the object of devising a satisfactory double mine-cord for portable electric lamps, often a weak feature of such appliances. These experiments are said to have led to the development of a cord 40 times as durable as the best cord previously available. The design of electric lamps for mines has also been the subject of study, and improved forms have been evolved. It is anticipated that 100,000 approved lamps will be introduced into coal mines during the next 12 months. A set of proposed safety rules relating to the use of electricity in bituminous mines has been prepared, and has received approval from leading coal-mine operators, and from the American Institute of Electrical Engineers. Another development is the use of storage batteries for operating locomotives, and avoiding the use of trolley-wires. Specifications for explosion-proof batteries are being drawn up, and promising results have already been secured. Finally, the Bureau has been at work on an electrical methane-detector, and it is stated that a highly sensitive form of apparatus, capable of detecting 0·25 per cent. of gas has now been produced.

Potash Production in the United States.—According to "Metallurgical and Chemical Engineering," the sandhills of Nebraska are capable of ultimately satisfying the demand for potash in the United States. Near Alliance four evaporating plants, aggregating over 5,000 boiler H.P., are now evaporating nearly 10,000,000 lb. of brackish water daily. In 24 hours something like 350 tons of salts, containing approximately [illegible] per cent. of water-soluble potassium oxide are produced, which is equivalent to 52,600 tons of K_2O per annum. Even this, however, is far below the needs of the United States, amounting to 275,000 tons. At the present time, owing to the stoppage of German supplies, the above plant, which has been very rapidly assembled, is extremely useful. One plant, furnishing about one-fifth of the output referred to above, started construction on Aug. 15, 1916, and shipped three carloads [illegible] days later. The prospect after the war is, however, somewhat problematical, seeing that the present cost [illegible] $40 a ton, whereas the German Schmidtman [illegible] contracted for [illegible] per cent. K_2O muriate at $15 a [illegible] (12 per cent. K_2O) at $2 a ton, even though the price of the former product was about $35 f.o.b. at American ports in 1912-1914.

Coolidge Tubes.—At the meeting of the Röntgen Society, held on Jan. 1, 1918, Mr. Carl Darnell read two Papers, communicated by Dr. Coolidge, of the General Electric Co.'s research laboratories, U.S.A. The first dealt with a new form of Coolidge tube, in which the anti-cathode consists of a block of copper faced with a small button of tungsten. This is fixed to a thick stem of copper, which passes out through the glass neck of the tube, and terminates in a fin radiator. The anti-cathode is thus kept cool, and does not in consequence emit electrons, as in the case of the earlier Coolidge tube, in which the whole of the anti-cathode speedily becomes red hot. The new tube therefore so completely rectifies current that when an alternating potential is applied only one phase of the current will pass. In the second Paper, by Dr. Coolidge and Mr. Moore, the portable or field X-ray outfit of the United States Army was described. A petrol electric unit supplies alternating current at 110 volts to a transformer arranged to give both high tension and heating currents for the new radiator type of Coolidge tube. For simplicity of control the tube is worked at a constant potential of 5 in. equivalent spark-gap, and the current is adjusted to 5 milliamperes for continuous running of the tube, or to 10 milliamperes for short periods. An electrically-actuated control on the throttle of the engine maintains constant output. The small size of the bulb, 3½ in. in diameter, enables a close-fitting lead-glass shield to be employed: this is made in two parts, and completely surrounds the tube, a suitable aperture permitting egress of the rays.

War Honours.—A long list of promotions in and appointments to the Order of the British Empire was published on Tuesday. A number of engineers, chemists and scientific men figure in the list, and among those well known to our readers are the following:—

KNIGHT GRAND CROSS (G.B.E.).—Sir [illegible] Garton (Founder of the Garton Foundation) and the Right Hon. Sir David Harrel (Chairman of Committee on [illegible]).

KNIGHTS COMMANDERS (K.B.E.).—[illegible] Dorman (Dorman, Long & Co.), Lieut.-Col. H. Fowler (Ministry of [illegible] and Royal Aircraft Factory), G. James (Brunner, Mond & Co.), [illegible] Director of Navy Contracts, John Mann (Controller of Contracts, Ministry of Munitions), James McKechnie (Vickers, Ltd.), Col. A. M. J. Ogilvie (Post Office), F. G. P. [illegible] (Siemens & Co.), Dr. Robert Robertson (Research Dept., Woolwich Arsenal), P. K. [illegible] (Ministry of Munitions).

COMMANDERS (C.B.E.).—Prof. [illegible] (Ministry of Munitions), Major A. B. H. Clerke (Hadfields, Ltd.), A. Davidson (Hattersley & Davidson), Hy. Glendinning (Brunner, Mond & Co.), A. E. Hadley (Ministry of Munitions), Prof. W. E. Hutchinson (Ordnance College, Woolwich), Prof. W. J. Pope (Admiralty Board of Invention and Research), L. L. Clarke (Adviser to Naval [illegible] in Wireless Telegraphy).

OFFICERS (O.B.E.).—F. E. Bagnall (Ministry of Munitions, Machine Tool Dept.), G. S. Baker (National Physical Laboratory), W. T. Bell (Kodak & Co.), G. T. Bennett (Compass Dept., Admiralty), A. E. Berriman (Daimler Co.), J. Bordeaux (Submarine Supt., G.P.O.), D. A. Bremner (late Head of Aluminium Section, Ministry of Munitions), A. D. Constable (Electrical Engineer's Dept., Admiralty), H. S. Coppock (Sir W. G. Armstrong, Whitworth & Co.), Claud Crompton (Ministry of Munitions), W. H. L. Ewart (Telegraph Dept., Foreign Office), Dr. E. C. Farmer (Research Dept., Woolwich), Prof. C. L. Fortescue (R.N. College, Greenwich), E. L. G. French (Munitions Inventions Dept.), I. H. Gibson (Admiralty Board of Invention and Research), E. [illegible] (Supt. Eng., G.P.O.), W. J. Gordon (Vickers, Ltd.), Dr. J. A. Harker (Munitions Inventions Dept.), Major C. Herbert (Ministry of Munitions), A. Matthews (Armstrong, Whitworth & Co.), [illegible]

[illegible]

[illegible] Harold Smith (Mather & Platt), [illegible]

Obituary.

SIR WILLIAM LINDLEY.—[illegible] took place at Putney of Sir William Heerlein Lindley, [illegible] civil engineer.

Deceased was [illegible] works on the continent. In 1873 [illegible] city of Frankfort-on-the-Main [illegible] 22 years. Among other public works [illegible] supply works of [illegible] Engineering Standards [illegible] Waterworks Engineers, and he was also a member of the Commission on Stray Electric Currents from Tramways. He was a member of the Institution of Civil Engineers [illegible] 1912 [illegible] to the Royal Commission on Canals and Waterways.

DEATHS ON ACTIVE SERVICE.—[illegible] been reported:—

Pte. R. Hills (London Regt.), formerly in the general office of the India Rubber Co., has been killed in action.

Gunner Chas. Nelson (R.F.A.), formerly an electrician at the Blackpool Tower, has died of wounds.

Pte. H. V. Atkinson (Lancs. Fus.), formerly a Burnley tramway employee, was killed in action on Dec. 25. He had been awarded the Military Medal.

Personal.

The directors of the North British & Mercantile [illegible] appointed Mr. John E. Bell, Assoc.I.E.E., who received his early training at Newcastle [illegible] and for some time past has been employed at the company's Edinburgh office as electrical inspector and surveyor, to be second officer at the company's Newcastle branch, with the title of sub-manager.

WAR CASUALTIES.—[illegible] reported:—

Corp. W. Brown (R.F.A.), formerly in the India Rubber Co.'s proofing department, has been severely wounded, and L.-Corp. G. Peters (R.F.) and Rfm. W. Ovens (K.R.R.), both former employees of the same department, [illegible].

Pte. E. T. S. Morris (London Regt.), formerly in the India Rubber Co.'s general office, has been gassed.

Bombr. F. Hardman (R.F.A.), formerly a Bolton tramcar driver, has been severely wounded.

Arrangements for the Week.

SATURDAY, Jan. 12th.

ASSOCIATION OF MINING ELECTRICAL ENGINEERS.

4.30 p.m. At the Royal [illegible] Paper on "Cable Complaints," by Mr. J. H. C. Brooking. An exhibition of different types of Cable Joint Boxes will be shown. Also a demonstration of Trailing Cable Jointing.

LONDON ASSOCIATION OF FOREMEN ENGINEERS.

7 p.m. At Cannon-street Hotel, London, E.C. Presidential Address by Mr. R. M. Campbell.

BIRMINGHAM AND DISTRICT [illegible]

[illegible] p.m. At the Swan Hotel, New-street, Birmingham. Paper on "A Brief History of [illegible]," by Mr. J. J. Richardson.

MONDAY, Jan. 14th.

FARADAY SOCIETY.

5.30 p.m. At the Royal Society of Arts, John-street, Adelphi, London, W.C. General Discussion on "The Setting of Cements and Plasters." [illegible] "The Setting Process in Plaster and Cement," by Dr. C. H. Desch; [illegible]

TUESDAY, Jan. 15th.

[illegible]

WEDNESDAY, Jan. 16th.

[illegible]

FRIDAY, Jan. 18th.

[illegible]

Mr. A. H. Marshall's Address to the Newcastle Local Section of the Institution of Electrical Engineers.*

I purpose to take as a subject of general interest, the use of electricity and its bearing on fuel saving in the iron and steel trades. With these trades the electrical industry will be associated for its greatest development in the immediate future. The war has given a great impetus to steel production, and in the period immediately after the war there seems to be every probability that the steel trade will continue to flourish. Up to quite recent times the mining of coal and ore, coking, smelting, steel making and rolling have all been more or less separate undertakings. There is every indication that the next few years will see a greater combination of interests, better application of capital and the utilisation of every means to economy.

With efficient plant and means for the recovery of surplus heat, it is commercially possible to meet all the heat and power requirements of a works that is laid out complete with coke ovens, blast furnaces, steel furnaces, and mills from the combustion of the coal fed into the coke ovens, without burning any coal in producers for the steel furnaces or in boilers for any portion of the power plant. This is an ideal arrangement. It has not been attained, because even the largest undertakings, although they can be made self complete under normal operating conditions, have not been able either to safely dispense with their coal-fired heating plant, or to justify the capital expenditure necessary to make full use of their waste energy. Yet that such an economical arrangement is attainable is evident if one applies the advantages of linking up to the electrical end.

I propose to put a few figures before you to show you how the energy of the coal, as fed to the coke ovens, is distributed in the processes of coking, smelting, and steel making.

In the following data in Table I., the heat available at each stage is expressed in terms of one ton of coal carbonised, and the products are those which correspond therewith. The energy values are given in kilowatt hours or kelvins, the latter being the better term, seeing that both heat and electricity are being measured.

I am dealing with the conditions of iron and steel manufacture on the North-East Coast, and have taken as a basis, one ton of ordinary Durham coking coal having a value of 12,500 B.Th.U.

Table I.—*Distribution of Energy in 1 ton of Coal* (12,500 *B.Th.U. per lb.*) [illegible] 8,200 [illegible]

Quantity of product.		B.Th.U.	Kw. hours available for conversion to power.
[illegible]			
5,500 cubic ft.	Gas used on ovens	690	
5,000 cubic ft.	Gas surplus	630	
0·7 ton	Coke	6,000	
[illegible]	Coke breeze	300	
100 lb.	Tar	470	350
[illegible] gallons	Benzol	110	
		8,200	
[illegible]			
31,700 cubic ft..	[illegible]	930	
73,800 cubic ft..	[illegible]	2,160	
1 ton	Slag (sensible heat)	650	650
[illegible]	Pig iron (sensibe heat) ...	250	
	[illegible]	2,010	
		6,000	
[illegible]			
[illegible]		1,200	300
[illegible]		390	
[illegible]		1,200	1,200
		2,790	2,500
[illegible]			
[illegible]			2,500
[illegible]			650
			1,850

[illegible]

[illegible]

coke ovens and 2,160 at the blast furnaces or 2,790 in all, about 1,200 can be made use of on the open hearth converters, and 390 in reheating the steel ingots.

The heat available for conversion to electrical energy or mechanical power consists of 350 units from the tar, 650 from the slag, 300 which can be recovered as waste heat from the steel furnaces, and surplus gas to the value of 1,200 or 2,500 in all. These units of heat energy converted at a thermal efficiency of 15 per cent. yield 280 units, and this on a coal consumption of 50 tons per hour, corresponds to an output of 14,000 kw.

Let us take the case of a group of works equipped with four 70-oven batteries consuming 8,700 tons of coal per week, five blast furnaces, each making 1,100 tons of pig per week, and sufficient open hearth steel furnace capacity and rolling mill plant to convert the whole of the pig iron make into finished steel sections. Eight thousand seven hundred tons of coal per week at a steady rate of consumption is approximately 50 tons per hour.

On the other side of the account the power consumed at the works would be as shown in Table II. The blowing plant requirements are based on 4½ tons of air per ton of coke, equivalent to 138,000 cub. ft. per ton of pig iron; theoretically it needs 1 kw. to deliver 1,600 cub. ft. of free air per hour under the usual conditions of temperature and pressure which, at a blower efficiency of 72 per cent., comes out to 120 units per ton of pig iron. For the rolling mills I have taken 110 units per ton of steel.

Table II.

KILOWATTS OUTPUT:

Coal consumed per hour	50 tons
Electrical energy per ton of coal	280 kw.-hour
Nominal output, 280 × 50	14,000 kw.
Minimum output, 14,000 × 0.6	8,400 kw.
Average output, 14,000 × 0.85	11,900 kw.

KILOWATTS LOAD:	Units required per ton of coal.	Mean kw.	Load factor.	Max. kw.
Coke oven auxiliaries... } Blast furnace .. ... } Steel furnace ,, ... }	40 × 50 ...	2,000 at	0·6 ..	3,300
Blowing plant (120 × 0·64)	77 × 50 ...	3,800 at	0·9 ...	4,200
Rolling mills (110 × 0·68).	75 × 50 ...	3,700 at	0·6 ...	6,500
		9,500		14,000

Average output units per week 11,900 × 168	2,000,000
Consumption ,, ,, 9,500 × 168	1,600,000
Surplus	400,000

The sum of the demands on this showing would be the same as the nominal kilowatt output. One should, however, allow for a stand by supply of 40 per cent. or, say, 5,600 kw. An allowance of 15 per cent. would probably be sufficient to cover the average deficiency of the generating plant making the average output 11,900 kw., and the units per week 2,000,000, while the total consumption 9,900 × 168 = 1,600,000, leaving a surplus of 400,000 per week.

The figures given in Table I. are based on the following values which, I think, are fairly representative :—

Gas per ton of coal coked	10,500 cub. ft.
Gas burnt on the ovens	5,500 cub. ft.
Calorific value of coke oven gas	430 B.Th.U. net
Tar per ton of coal coked	100 lb.
Coke per ton of pig iron	22 cwt.
Gas from blast furnaces per ton of pig iron	165,000 cub. ft.
Calorific value of blast furnace gas	100 B.Th.U.
Slag per ton of pig iron	30 cwt.
Heat required at steel furnaces per ton of steel	6,000,000 B.Th.U.
Heat required for reheating	2,000,000 B.Th.U.

* Gas values being at normal temperature and pressure.

The coke oven results are those obtained with any well known [illegible] by-product regenerative oven, operated under ordinary [illegible] conditions. About one half of the gas produced goes to heat the ovens, and the other half becomes available for outside use. [illegible] gas can be used for the production of power by [illegible] or boilers. It is not so suitable as producer or [illegible] gas for gas engines, because of sulphur and pre-ignition troubles. [illegible] it gives a greater output for the same heating surface than coal. It is being largely used as fuel for steel furnaces.

The consumption of coke in the blast furnace may be taken at about 22 cwts. per ton of pig iron. The air or blast required to provide sufficient oxygen to convert the carbon (less what takes part in other reactions) into the reducing agent carbon monoxide, is about 4½ tons per ton of coke. Apart from its principal function of smelting iron, the blast furnace may be looked upon as being a large gas producer. The air for the blast is usually heated by means of brickwork stoves of the regenerative type, which makes the first call on the gas from the furnace. The stove efficiency may reach about 70 per cent. The kw. hours of heat corresponding thereto are 930, and these, added to the 2,010 units for "furnace reaction and loss," represent the quantity of heat absorbed in the smelting process.

The heating of the basic open hearth steel furnaces and mixer is commonly done by means of a simple form of gas producer, consuming about 6 cwt. of coal per ton of steel ingots, and giving off a gas having a calorific value of 130 B.Th.U. Both coke oven gas and blast furnace gas can be and are used for this purpose, the former for preference. About 6,000,000 B.Th.U. of 1,760 kw. hours per ton of steel will be required.

The burnt gases from the open hearth furnace leave at a temperature of about 1,100°F. There is consequently a great deal of waste heat, which it is found can be recovered by fitting boilers in the flues leading to the chimney stack. About one-fourth of the heat supplied to the furnaces is available for the raising of steam.

The heat required at the soaking and reheating pits may be taken at 2,000,000 B.Th.U. per ton or 580 kw. hours.

Looking at the figures given in the table from the point of view of power production, the first available source of energy is the tar from the coke oven gas in the by-product plant. An average yield is about 100 lb. per ton of coal carbonised, having a heat value of 500 kw. hours. Practically all metallurgical coke is now made in by-product ovens.

The 650 units available from the slag represent the sensible heat in the slag as it comes from the furnaces. So far as I know this heat has not been put to any commercial use hitherto, mainly because the gases and other sources of waste heat which are in a more useable form have not been fully exploited. It is, however, a possible source of energy.

The blast furnace gas forms by far the largest item of available heat, and its use, therefore, calls for special consideration. After the requirements of the steel plant are satisfied, there may remain 2,160 units available for power purposes. Gas engines of sizes ranging from 1,000 to 5,000 H.P. have been built for driving both blowers and generators, and a considerable number are now in use.

The whole of the blast furnace gas should be cleaned of the dust which it contains, both for heating and power purposes. Beside the frequent boiler cleanings which are necessary, the whole of the furnace plant has to stand for a day or two about every three months to permit of the flues and stoves being cleared of the great quantity of dust which accumulates. There are two systems of cleaning in vogue, one necessitating the use of a large quantity of water atomised and intimately mixed with the gas in suitable centrifugal apparatus from which the dirt comes away as a sludge, and the other a filtering or dry method. Both systems rob the gas of the greater part of its sensible heat. Recently, and more particularly because of the demand for potash, consideration is being given to an electrostatic method of dust extraction developed by Dr. Cottrell in America and used with great success.

In old established Cleveland practice the surplus heat from the blast furnaces is converted into power by means of shell type boilers in open settings and non-condensing steam engines at a thermal efficiency of about 5 per cent., and as a consequence there is usually little gas to spare. The advent of the exhaust steam turbine has [illegible] economy by another 5 per cent. [illegible]

[illegible]

A 15 per cent. thermal efficiency for modern steam plant [illegible]

[illegible]

There are no statistics available of the quantity of coal at present used in the several processes of iron and steel manufacture, and I can, therefore, only [illegible] would be saved with a complete system of heat recovery such as I have described. Assuming that on the average the coke oven and blast furnace gases now supply the blowing plant, the auxiliaries and one-fourth of the requirements of the rolling mills, then more coal would come into the scheme to the extent of that needed for three-quarters of the rolling mills and for the steel furnaces—an additional quantity which I would not like to put at a less figure than 11 cwt. per ton of steel, and which on last year's output would amount to about 5,500,000 tons per annum. This coal would be saved and there would still be left a surplus of energy above the works requirements.

The advantages claimed for the electrical reversing mill have been well substantiated in practice, as is borne out by the fact that there are at the present time under construction at least seven reversing mill equipments ranging from 10,000-20,000 H.P. in size, capable of doing the heaviest class of work, both roughing and finishing, with outputs of over 50 tons per hour. These new mills will together have a capacity of well over 1,000,000 tons of steel per annum. In addition there are numerous alternating-current motor continuous mill drives being installed in sizes of from 2,000-10,000 H.P.

The most recent electrical development and steel works practice, and one which has received a great impetus from the war is that of the electric furnace. It may be that the quality of steel rails, for example, produced or partly produced electrically, will be such as to command a price high enough to bear the additional cost of production. An average figure for melting and refining is 750 electrical units per ton, which may be compared with the heat absorbed by an ordinary gas-fired furnace, as shown in Table I. At this figure the mean demand would not be less than 2,600 kw., and the maximum about 3,500 kw. This addition to the mean load brings it up to 12,100, or nearly the same figure as that taken for the average output of the generating plant.

As an illustration of the scope of future electrical development, the total electrical energy to be dealt with, assuming the figures given to apply to a make of steel of 14,000,000 tons, and not counting the power taken by the blowing plant, works out at 3,300,000,000 units per annum, with a maximum load of over 600,000 kw.

Faraday Society.

The annual general meeting of the Faraday Society was held on Dec. 12, 1917, when, in the unavoidable absence of the president, the chair was taken by Mr. W. R. Bousfield, K.C., F.R.S., vice-president. The resignation of the treasurer, Dr. F. Mollwo Perkin, who had acted in that capacity since the formation of the Society in 1903, was received with much regret. Mr. Robert Mond, F.R.S.E. was elected as his successor.

The following officers and members of Council were also elected:—

President: Sir Robert Hadfield, Bart., F.R.S.

Vice-Presidents: W. R. Bousfield, K.C., F.R.S., [illegible] F.R.S., Dr. Eugene Haanel, Prof. A. K. Huntington, Dr. T. Martin Lowry, F.R.S.

Council: [illegible]

[illegible]

Some Points of Interest to Northumberland and Durham Colliery Engineers.*

By A. C. NELSON.

Th[illegible] district in Great Britain which has the electrical [illegible] Northumberland and Durham, including the resources of one of the largest coal-power electric supply companies in the kingdom, which, on account of its size, can offer current to its consumers at a very low price per unit.

The two counties mentioned are separated by the river Tyne, [illegible] geologically two distinct qualities of coal. The coals on the north side of the river are hard steam or non-coking coals, whereas those on the south or Durham side are the best coking coals [illegible]. The [illegible] there being no coke ovens north of the Tyne (in Northumberland) opens the door to the power supply company, and practically all the Northumberland pits will finally find it to their advantage to take their supplies of current from this source. In Durham many of the pits have coke-oven plants, from which a large and valuable amount of waste heat is given off. The cost of fuel in the production of power is approximately 70 to 75 per cent. of the total cost. Where there is waste heat available the colliery companies naturally make use of it for power production; but, even then, it seems the best procedure for the coal companies is to make an arrangement with a supply company to generate current from this waste heat for them, as is done in several cases in Durham. For a Northumberland colliery to start and generate its own supply of electricity, except in special cases, would be a complete waste of time. The large colliery can make power more cheaply than the small colliery, but not as cheaply as the central station. The [illegible] to get coal, and the manager is trained on these lines. He can never give it the same attention that the central station organisation does, nor can he understand it as well. Furthermore, he cannot afford to hire the quality of brains that efficient power production demands. The time that the executive gives to an isolated plant must be taken from other work, on which the manager is more efficient, on which the dividends of the concern depend. Power ordinarily represents about 5 per cent. of the total cost of production. The use of an isolated plant compels the manager to [illegible] to this 5 per cent. time that could be spent more efficiently on the remaining 95 per cent. The central station necessarily has a better load factor and diversity factor than has the isolated plant, which must be built for the maximum load of one establishment. Finally, extensions are less expensive. The money for an isolated plant can ordinarily be secured only by bringing the concern that uses it nearer to the limit of its borrowing capacity.

During the last six years I have been constantly engaged in substituting electrical plant for steam plant. Our pits produce non-coking coal, and we decided to avail ourselves of the central station supply. The first steps of the electrification were directed in cutting off the low-pressure boilers and the naturally inefficient engines working from them. In each case comparative prices and cost were taken of up-to-date steam plant and electrical plant, and it was found in most instances that the electrical plant had the advantage.

In comparing costs of electricity taken from a supply company with those of steam plant colliery engineers are very apt to err in favour of the latter. Depreciation and maintenance charges for steam plant are commonly under-rated. For instance, it is wrong only to take the cost of coal used plus cost of firemen and cost of repairs and depreciation on the actual boiler plant. Depreciation, maintenance and repairs should be taken on steam pipe ranges, water pipe ranges, boiler pumps and joints of same, which require more renewals and repairs than electric cables. Special railway sidings, wagons and bunkers are necessary for supplying coal to boilers; these need repairs and renewals, and the sidings have to be [illegible]

[illegible]

INSTALLATIONS AT WALLSEND AND HEBBURN.

I propose to give a few particulars of the plant we have installed at the Wallsend and Hebburn Collieries during the last few years. The electrical plant installed is approximately 13,000 B.H.P., and the amount of current used is 11,000,000 units per annum.

We have installed two large direct-coupled winders, duplicate with each other, and at the present moment a third is being installed. All the parts of the three winders are interchangeable. Particulars of these are as follows :—

Motor, 730/1,950 B.H.P., three-phase induction type, wound rotor and slip rings, 50 revs. per min., which is direct coupled to shaft.

Depth of shaft	1,080 ft.
Weight of cages and slings	86 cwt.
Weight of tubs	6 tubs at 6 cwt. each = 36 cwt.
Weight of coal per wind	60 to 72 cwt. We have 9, 10 & 12 cwt. tubs.
Weight of rope per yard	14 lb.
Diameter of rope	1·67 in.
Class of rope	Improved patent plough steel langs lay
No. of tubs per wind	Six.
Tons wound per hour	160 to 180, according to tubs.
Time of winding	50 seconds.
Time of changing	10 seconds.
No. of decks per cage	Three.
Type of guides	Steel rail.
Volt'ge at motor terminals	2,750 volts.
Cycles	40.
Amperes, accelerating	Start 375 (after six revs.) 175
Amperes, steady running	140 to 170.
Units per wind	5·7*
Units per ton	1·9
Drum	Parallel, 12 ft.
No. of turns on scroll of drum	28 turns of rope on drum and three dead turns.
Ratio of gearing	Direct.
Type of controller	Type LB 7B liquid, with fixed electrodes, electrolyte being circulated by a pump and cooled by water circulation.
Makers of winder	British Westinghouse Elec. & Mfg. Co. (Ltd.)
Life of ropes	Over $3\frac{1}{2}$ years.

At our Edward Pit we have installed a small geared winder of the following dimensions: Motor, 125 B.H.P. normal, 250 B.H.P. maximum, 230 revs. per min., 2,750 volts, three phase, 40 periods. The winding engine is designed for raising a net load of 30 cwt. from a depth of 834 ft. at a maximum speed of 660 ft. per minute.

Drum speed	23·3 revs. per min.
Motor speed	230 revs. per min.
Drum	9 ft. diameter on tread by 8 ft. wide.

Power Plant Company's gearing, machine-cut double-helical staggered teeth, cast-steel spur wheel, forged steel pinion, 15 to 149 teeth, enclosed in an oiltight casing.

Although my experience has been mostly with large direct-coupled winders with parallel drums, I am very favourably impressed with the work of the small geared winder we have installed. The advantage of eliminating the gear as a source of breakdown must not be forgotten, but the efficiency of gearing has so increased during the last few years that this point can now be ignored with safety, and, providing that simultaneous decking is possible, a geared winder with conical drum is better practice. With geared winders the motor does not require to be so massive, and the starting and stopping movements are more simple. An interesting fact which has developed in the use of electric winders is that the life of the winding rope is considerably increased. The continued stopping and starting of winders makes the switchgear a most important part of an electric winder equipment. The work it has to do is enormous. The [illegible] reversing switches supplied were not properly constructed for the work. Being operated by hand and in conjunction with the rotor resistance, which was practically all cut out the moment when the switch was closed, if the brake was released at this point the winder raced away at full speed. The result that the rotor resistance had to be put in circuit again before the brake could be released and the winder set in motion at a slow speed. The result of this was that the switch [illegible] opened again and a fresh start had to be made.

* [illegible] guarantee that the total energy consumption per wind, including [illegible] but not including changing decks, shall not exceed, when raising [illegible] of coal:—

A	B	C
[illegible]	1,100	1,221 ft. shaft
[illegible]	[illegible]	6·2 units

* [illegible]

This not only lost time in coal drawing but reduced the life of the switch contacts. Heavy rushes of current obtained at the moment of making switch contact when the rotor resistance was practically all out caused arcing between phases, finally breaking down the insulation. To obviate the above faults, the makers designed and supplied an electrically and air-operated set of stator reversing switches, of ample dimensions for oil and greater distance between phases. Also provision was made for releasing the gases generated by the breaking of heavy currents in oil.

For the sinking of one of our Rising Sun shafts, 22 ft. diameter, 140 fathoms in depth, we decided to use the permanent electric winder and switchgear, and were very soon more than satisfied with the results. Water winding to the extent of 500 gallons per minute was dealt with by the winder during the sinking. The conditions of sinking with an unbalanced load are a severe test on switchgear, but we had no trouble whatever. The cost of maintenance on these switches for 12 months' winding coal is as follows: 46 contacts, £19; 10 contact springs, 7s.; 66 gallons new oil, £10. 14s. 6d.; 80 lb. white waste, 13s. 6d.; and time, £4. 5s.; total £35.

Before leaving electric winding, I should like to show a point in favour of its greater safety as compared with steam winding. When a steam winder is in motion, the braking is, in some cases, done by putting the steam against the winder. If this is done too severely, it might easily draw the rope from its socket and precipitate the cage to the pit bottom. In electric winding the switches can be set to do easily the ordinary braking, but would trip in the event of a too severe application. The smoother running and more regular speed of these winders make them easier to handle with a minimum of braking. The same switch setting makes the operator use his brakes for all ordinary purposes, only using reverse current when absolutely necessary.

Underground Haulage.—In this class of work electricity, owing to the intermittency of the work and the distance from its source of power, shows its great advantages. For the main haulages it is ideal, and, when taken underground, it obviates the abomination of a running set of ropes in the shaft or the alternative of pipes down the shaft. It must not be forgotten that both the ropes and pipes in the shaft are restrictions to the ventilation. For the secondary haulages it also has great advantages. For large main-and-tail and direct-haulage gears the liquid type of controller with reversing switches is by far the best. They are slightly more expensive in first cost, but considerably cheaper to maintain. They are also less liable to breakdown.

In the original Paper detailed particulars of haulages recently installed are then given, and are followed by data on some recent changes in systems of ventilation. These changes proved highly beneficial and economical in working. The total saving effected is calculated to amount to 3,167,550 [illegible] per annum.

The application of electricity to fan drives, with the motor connected directly to the fan, is attended with difficulty owing to the speed of ordinary motors being constant. In the case of motors driving fans through belts or ropes, we have also found that the changing of pulleys to give an increase or decrease in the revolutions of the fan is also, to a certain extent, not altogether reliable. The change has often to be done at week-ends, and is hurried, and the results are sometimes hardly what are anticipated. To avoid this, we are installing a 150 H.P. adjustable speed polyphase induction motor with seven speeds—namely, 260, 300, 340, 400, 480, 600 and 800 revs. per min.

In the original Paper the author next gives full particulars of the pumping machinery in the [illegible], which is electrically driven.

Electrical air compressing [illegible], owing to the inelasticity of the speed of polyphase motors, attended with difficulty of economical regulation, as with electric drives of fans. When the pressure is reached with a steam compressor, the governor comes into action and slows down the engine until pressure is again required. In the case of a motor drive we have tried several types of control with a view to economy when the compressor is not fully employed, and have finally decided that [illegible] is the best practice. The following [illegible] on a 3,000 [illegible] present, show the saving to be gained by installing this gear. The compressor and motor require [illegible] load when running light, therefore the energy consumption would [illegible] at a power factor of 0.[illegible]. Assuming that the cost of current is one-third of a penny per unit, the cost of one hour's running light would [illegible]. Assuming a six days' week of 144 hours, and that during only one-third of the period the set [illegible] running light, then the cost of energy per week would be 48 times [illegible], which equals [illegible] per week, which represents [illegible] per annum. Added to this we get more efficient compression, and [illegible] the bearings are cooling during standing periods.

Screens and Shops.—All the machinery for our screens and shops is driven electrically and on the unit system. In the case of screens, each belt and tippler has its own motor, and, as the same size of motor is usually employed for driving shops, the advantage as regards spares is obvious. Each blacksmith's hearth has its own motor, so that the night-shift blacksmith, instead of running a large blower of, say, 5 H.P., runs his own small ½ H.P. blower, and that only when he requires the draught.

Electric Miners' Lamps.—We have at present 1,000 electric miners' lamps of the Ceag type, which are used chiefly by the putters. These lamps, although more expensive in first cost and maintenance than oil lamps, justify their adoption for the following reasons: It is practically impossible with ordinary use to lose your light, as in the case of an oil lamp, which goes out with the slightest knock or fall. This avoids the putter having to walk a considerable distance in the dark to a lighting station, which usually causes some loss of work to the hewers. By their better and more continuous light they increase the output. They reduce accidents and facilitate the repair and replacing of tubs on rails. Although the makers claim many other advantages for them, these are the points that appeal to us. Before leaving this subject, I should like to mention that I consider there is a great future for a good dry-cell miners' lamp. For the re-lighting of the oil lamps underground we have installed several magneto re-lighters in place of the sparking coil and accumulator type. This avoids the carrying in and out of the mine of accumulators and charging of same, and the result is a more efficient re-lighter, with practically no maintenance cost.

Signals.—All of you will remember the long, weary trails in-bye to put right the battery of Leclanché cells attached to the underground signals. Some three years ago we adopted the practice of supplying our shaft and underground signals with current from motor generators and accumulators in place of these, with the result that faults are practically nil and maintenance charges have been reduced to a minimum, whereas, in the days of Leclanché cells, stoppages were numerous, renewals expensive and the relations of the management and electrician always at breaking point. Some time ago we installed a Sterling shaft-signalling system at one of our pits, which has been so satisfactory that we have placed orders for similar systems to be made for our other pits. The construction of the apparatus is of the most substantial description and practically unbreakable.

Before concluding, I should like to mention one great advantage of taking a supply from a power company in abnormal times. When our pits are idle for want of shipping or from any other cause, such as strikes, &c., our power costs are reduced to a point which no colliery company, either steam driven or generating its own electricity, can ever hope to achieve.

Creep of Rails. Two Papers on this subject were read before the Institution of Civil Engineers on the 8th inst. The first was by Mr. F. Reeves. It occurred to the author some years ago that light might be thrown on the cause of rail creep by making a few simple experiments. He began by passing a wooden wheel several times in succession, in one direction, over a planed white pine lath resting on a hardwood bench, and found to his surprise the lath had moved bodily about 2 mm. in the direction of travel, the total amount of the latter having been about 11 metres. [illegible] the author, in common with many other railway engineers, had held the opinion that creep was probably in the main due to temperature changes assisted by the movement of trains. He therefore tried a further series of experiments, not only with pine laths, but also with flat iron bars [illegible]. The general conclusions at which the author arrived were: (1) Creep of rails is due primarily to deformation of the rail as the wheel passes over it. It may be likened to the movement of dough when rolled under a rolling-pin. (2) The greater the deformation the greater the creep; that is to say, that creep is increased by (a) increasing the wheel load; (b) decreasing the rigidity of the rail [illegible]. (3) Creep is greater down hill than up hill, but is by no means absent on the level. [illegible] The second Paper was by Mr. H. F. M[illegible], and described investigations of the phenomenon of creeping rails made by him for a period of [illegible] years, on a length of line in this country, of which he had charge, consisting of 850 track miles of main and branch lines.

The Commercial Development of Engineering in China.—II.*

By S. W. B. McGREGOR, A.M.Inst.C.E., M.I.Mech.E.†

ELECTRICAL DEVELOPMENT.

Japan is an important factor in considering the possibilities of electrical business in China. She has advantages over Western nations in cheap freights, cheap labour and in the lower cost of copper. Certain unscrupulous Japanese manufacturers have caused annoyance and some loss to British manufacturers by copying and selling certain articles protected by patents and otherwise, adding also, sometimes, the original trade marks and manufacturers' name. It is difficult for British manufacturers to protect their interests in a country like China, which has no patent or trade mark laws, but no doubt the Japanese Government will find means to deal with the many complaints which have been made, and put a stop to the practices referred to. In regard to small fittings, lamps, insulated wire and cable, the Japanese are making a serious attempt to capture the Chinese market. The material they are turning out suits the market, whilst their selling organisation is excellent, commercially and technically.

Previous to the war it must be admitted that British electrical manufacturers had no organisation in China that could seriously compete with the American and German concerns, particularly the latter. The figures show that we do about 50 per cent. of the electrical trade with China, but this is due more to British influence in various forms than to efficient selling organisation. Apart from the question as to how far it is worth while to seriously tackle the China market, it is very much easier to state the difficulties of the situation than to suggest methods of overcoming them. The individual large firms may well be left to investigate and form their own conclusions; for the others it would almost appear that representative associations, such as the B.E.A.M.A. and British Engineers' Association, should be able to offer advice.

Some general observations on selling organisations are given later on in this article.

Electric tramways exist only in four towns, Dairen (Manchuria), Hongkong, Shanghai and Tientsin. Concessions have been granted for the cities of Hankow and Peking; that for Hankow is British, but in the case of Peking there are several claimants for the concession, of which the strongest appears to be the Banque Industrielle de Chine (French). The existing tramways are a great success, particularly the Shanghai system, but there are no other immediate possibilities beyond those mentioned, as the ordinary Chinese city streets are so narrow that a tramway means wholesale widening and repaving.

The telegraph system now belongs to the Chinese Government and is rapidly extending. In 1913 the figures were:—

Length of land lines	37,403 miles
[illegible]	41,103 „
[illegible]	1,002 „
[illegible] cable	102 „
[illegible]	1,789 „
[illegible]	1 „

Chinese [illegible] are telegraphed by means of a code in which a number is allotted to each character.

There is a growing tendency to advertise publicly for tenders for telegraph supplies, but the methods adopted are not satisfactory [illegible] prices are asked for [illegible] of [illegible] of sterling [illegible] and it is difficult to induce British manufacturers to take the necessary trouble in preparing tenders, which are not likely to be considered [illegible] on their merits.

Wireless installations supplied by the Telefunken and Marconi companies have been erected at some [illegible] centres, of which the principal are Peking, [illegible], Shanghai, Woosung, Wuchang and Canton; considerable extensions are pending under the Marconi system.

Telephone systems exist in 14 towns and extensive developments may be expected. Figures as to numbers of subscribers have not been published. The general tendency is to adopt American and Scandinavian instruments.

OTHER INDUSTRIES.

The present stage of industrial or factory development in China is indicated by the following statistics from the "China Year-Book of 1916":—

Factories, &c.

Albumen	11
Arsenals, Government	15
Breweries	16
Cement and brick works	15
Chemical Works	2
Cotton, spinning and weaving (spindles 1,000,000, looms 6,000)	56
Docks, shipbuilding and engineering works	23
Electric light works	60
Flour mills	41
Gas works	4
Iron and steel works	1
Mints, Government	7
Oil mills	35
Railway workshops	11
Rice mills	10
Saw mills	21
Smelting works	10
Tramway systems, electric	4
Waterworks	17
Telephone systems	14

These figures show substantial progress, but, more particularly how little has really been accomplished when the area and resources of the country are considered.

Of the various factories, cotton spinning mills are the most important, and great developments may be expected as soon as conditions permit. Electric driving for these mills is well to the fore, particularly in the Shanghai district. The Chinese Government, recognising the importance of cotton mills in the commercial development of the country, is adopting measures in regard to improved methods of growing cotton and the erection of mills. All the natural conditions exist for growing cotton of excellent quality in almost unlimited quantities. The difficulties in the way are the antiquated methods of the Chinese and the system of small holdings under which the proprietors will not part with their land. This, together with the fact that foreigners cannot own land under any circumstances, makes it impossible for cotton to be grown under proper conditions and on large areas.

Flour milling is a slowly developing industry. Bread is one of the few things that is new to the Chinese. It is not acceptable to them and is said to be beyond their powers of digestion. On the other hand, flour is being used in increasing quantities for various cooking purposes. The imports of flour into China in 1913 were 150,000 tons, valued at £1,600,000. The machinery in the flour mills is mostly of American origin, as being cheaper than British, whilst the American selling methods in this class of machinery are better adapted to the idiosyncrasies of the Chinese. Wheat to the value of £700,000 was exported in 1913. Vast territories exist in the North suitable for the production of wheat on a large scale, but await development as in the case of cotton.

Oil mills and kindred plant for dealing with native produce offer [illegible] prospects. The value of this trade, excluding tea and silk, was about £25,000,000 per annum. The bulk of the produce was shipped to Continental ports and the business was [illegible] in German hands. American and Japanese as well as British firms are making strenuous efforts to capture this produce trade, which is likely to largely increase after the war, and considerable quantities of machinery will be required for cleaning, grading, [illegible] and packing.

* The preceding article appeared in The Electrician of Dec. [illegible], p. 338.

† Mr. McGregor [illegible]

Agricultural machinery shows small prospects of development. The farmers or peasant proprietors are very ignorant, extraordinarily conservative, extremely poor and altogether lacking in the spirit of co-operation. They are content with their primitive home-made appliances, distribution to any distance is at present impossible, whilst labour is cheap and unlimited in quantity.

The immediate prospects of the development of the use of machinery in factories or works, other than those mentioned, are not very great. The wants of the people are very limited and labour-saving machinery or appliances do not appeal to them. The Chinese themselves appear to be incapable of successfully managing any manufacturing or producing concern except on the smallest scale, whilst the enterprise of foreigners is restricted by the insecurity of property and inability to own land outside the Treaty ports.

In the foregoing an attempt has been made to give a rough idea of the actual conditions prevailing in China. In dealing with the purely commercial aspect it is desirable to consider the engineering and metal trade returns. The 1913 figures are given below as being the best results so far obtained and free from war interference. The estimated percentages of engineering material and metal products supplied by various countries are also given.

China Engineering and Metal Trades, 1913.

	A.* Exports from Great Britain	B.† Total imports from all countries.
Metals, iron and steel	£1,100,000	£2,600,000
„ other than iron and steel	120,000	1,700,000
Machinery, all kinds, including electrical	40,000	1,840,000
Arms and munition	[illegible]	1,060,000
Electrical goods and material other than machinery	[illegible]	160,000
Ships and boats	[illegible]	Not recorded.
Total	[illegible]	£7,660,000

Percentages of Engineering and Metal Trades (approximate).

Great Britain	30 per cent.
Germany (arms and munition 10 per cent.)	23 „
Japan (copper 12 per cent.)	21 „
Belgium	11 „
United States of America	6 „
Russia	[illegible] „
France	1·5 „
Other countries	2·5 „
	100 per cent.

The Chinese customs are directly controlled by foreigners, British predominating, and their figures may be taken to be accurate.

Being a British Possession, the Chinese Customs have no jurisdiction over Hongkong and treat that Port as a "foreign" country in regard to statistics. The import and export trade of Hongkong with China (Chinese Customs figures, 1913) was £15,000,000, or nearly one-third of the total trade of China. No records are kept at Hongkong of the countries of origin or destination of either imports or exports; consequently percentages of each country's trade can only be approximately estimated.

The outstanding feature of the engineering and metal trade figures is the smallness of the business done. Particularly is this the case with machinery exports from Great Britain. The figure, £40,000, is made up as follows:—

Machinery.

Locomotives	£10,000	
Pumps	[illegible]	
Electrical	11,000	
Boilers	[illegible]	
Mining	[illegible]	
Sewing Machines	[illegible]	
[illegible]	[illegible]	
Unenumerated	[illegible]	
		[illegible]
[illegible]		[illegible]
„ [illegible]		[illegible]
Implements and tools		[illegible]
		[illegible]

[illegible]

* British Board of Trade figures [illegible]

† Chinese Customs figures [illegible]

A considerable proportion of the trade in British machinery and metals was in the hands of American, German and Japanese firms, so that the amount of business remaining for British firms resident in China was very small indeed compared with the great size of China, the many difficulties and great cost of getting business.

THE DEVELOPMENT OF TRADE.

The smallness of the immediate possible business is the dominant factor in the China problem.

The Japanese firms, with many natural advantages, have proceeded methodically to work and are able to carry on their propaganda work and business organisation at a very low cost in salaries and expenses.

American firms have made a somewhat dramatic entry into the Chinese market, with success in certain directions, but it remains to be seen how long they will be content to spend large sums of money on future possibilities.

The German firms have tackled the China question in their usual thorough manner and adopted such expedients, legitimate and otherwise, as might be considered necessary to break into a market, formerly, practically in the hands of Great Britain. They clearly worked for the future, and their engineering business was done largely on credit terms and with small profit, if not at a loss. By reason of their *apparent* superior business methods, they obtained credit from British banks which was often withheld from British firms, they had advantages in business connections with the Chinese due to their handling of native produce, and, not least, as agents for the German dye works, they divided an annual income, amounting to a subsidy, of about £100,000. About 30 British manufacturing engineers have had German or Austrian agents in China, including some of our largest armament and textile machinery firms.

The British record of trade generally is, on the whole, one of steady progress, financial success, business based on sound foundations and, with all, we have retained the goodwill and respect of the Chinese, who have shared in our prosperity.

In regard to British engineering it is not too much to say that our trade is due to our influence and reputation rather than to scientifically organised selling arrangements. Too often have manufacturers sent representatives to China whose actual or supposed qualifications have been influence to obtain orders and not ability to put their principals' business on a sound basis.

It will be found that the commercial development of engineering in China, apart from diplomatic and financial considerations turns almost entirely on the question of manufacturers' representation. To the merchant firms belongs the credit of opening up China and carrying on such engineering business as we have. These firms have [illegible] engineering departments as a side issue to their main business, with the hope that the use of machinery would increase to an extent such as would put the engineering departments on a paying basis. These hopes have not been justified, with the [illegible]

[illegible]

1. [illegible]

2. [illegible]

3. Manufacturers to induce existing merchants of standing, having the organisation for doing business and the necessary connections, to open or re-open engineering departments.

Of these methods (1) is applicable to very few firms by reason of its great cost, (2) has all the usual drawbacks to co-operative methods, (3) involves initiative on the part of the manufacturer, the payment of substantial subsidies towards expenses, and in most cases the supply of one or more of the manufacturers' own expert representatives. This latter method has the great advantage of using existing machinery for doing business, the use of valuable business connections which have been the growth of years, and also by means of his own representatives the manufacturer keeps in close touch with the market and the consumer.

The question of penetrating the interior as regards engineering material is much to the fore now, but it would appear first of all necessary to create efficient organisation [illegible].

Much [illegible] existing or new organisations being created by British firms, in connection [illegible] firms in the past.

In conclusion, it is hoped that these notes, whilst dwelling on the difficulties of developing engineering business in China, [illegible] possibilities in a not too distant future.

There are many lessons that Western people can learn from the Chinese, and if we, rather lightly perhaps, say they have awakened from their slumbers, they are possibly entitled, as being distinctly friendly towards us and from their contact with other nations, to hope that Great Britain is throwing off the lethargy with which she appears to them to have dealt with engineering business in China.

Electrical Signalling and Control on Railways.*

By C. M. JACOBS.

Electrical methods are generally preferred for the control of indications required by drivers and signalmen in connection with the two main divisions of railway signalling, viz. :—

1. Block signalling, which has to do with keeping trains running on the same line of rails properly spaced ; and

2. Interlocking signalling, the function of which is to ensure that the points over which the trains have to pass are properly secured, and to govern movements in and about station yards and junctions generally.

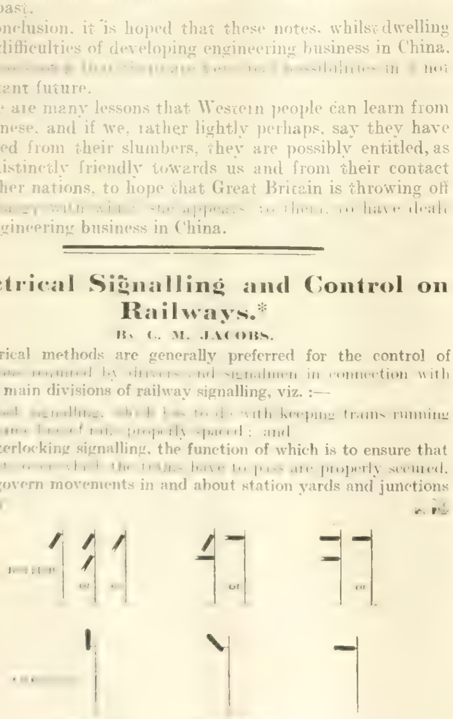


Fig. 1.

[illegible]

[illegible]

[illegible]

said for an audible indicator which would sound when the signal and lever controlling it were not in agreement. Mere indication of the position of the signal is not enough. In block signalling it should not be possible to place a signal in the "Proceed" position unless at the same time the signal in advance is at "Stop." Fig. 2 shows an arrangement for effecting this, including an audible indicator which sounds when the lever and signal are not in agreement.

Where interlocking signalling is concerned, it is necessary also to have the signals in the "Stop" position if the points on the route controlled by the signal are not in their correct position. These safeguards can only be made thoroughly effective by working the signals and detecting the points electrically.

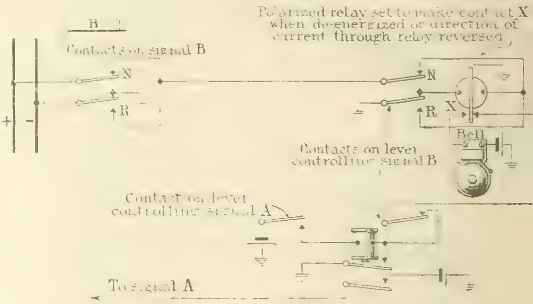


Fig. 2.

In an installation of electric detection of points and signals, a large number of wires have, of necessity, to be run close together, and precautions are required to prevent crosses or earths from causing the improper operation of the detector relays. On this account, and also in order to admit of faults being more easily traced, "common" conductors are to be avoided, while an independent source of energy for each indication circuit is to be preferred. The McKenzie & Holland and the Westinghouse Power Signal Co.'s arrangement for this, utilises alternating current with a separate transformer for each indication circuit.

Electrical methods of point indication and control are mostly confined to power systems of signalling. They are, however, being introduced in connection with mechanical signalling installations.

Track Circuit.

Signalling movements are further controlled by the presence on the rails of trains and vehicles themselves by means of track circuits. The track circuit ideal is to detect anything on wheels across the rails, but in practice a 4 ohm or 9 ohm relay and a 1 volt battery, cannot be depended upon to detect anything but a virtual short-circuit across the rails.

Track circuits may be divided into three classes :—

(a) Those which may be acted upon by complete trains only.

(b) Those which may be acted upon by a single vehicle.

(c) Facing-point track circuits, which, being short, have a comparatively high ballast resistance.

These track circuits should be adjusted for minimum train shunts at infinite ballast of 5, 10 and 20 ohms respectively.

This necessitates a higher ballast resistance, possible perhaps only by sub-division of the track circuit, a higher resistance relay, a higher battery resistance, and a track battery having a higher electromotive force.

This will be evident from the curves in Fig. 3, from which can be obtained all the factors for any track circuit. These curves show the shunt required to reduce the current through the relay to any fraction of the current which would pass through the relay unshunted. The shunt resistances and the battery series resistances are in terms of the relay resistance.

These curves show that the rule that the higher the battery series resistance the more sensitive is the relay to shunting, does not completely represent the law of the shunt as applied to track circuit conditions.

For efficient shunting, the lower part of the curves should be used ; the fraction of unshunted relay current through the relay at minimum ballast should not be greater than 0·1.

The standard type of track relay of 240 ohms requires about 0·01 ampere as the minimum pick-up current, so that the unshunted relay current must be 0·05 ampere, to drive which through the unshunted relay plus the battery series (0·5 relay), i.e., a total of 360 ohms, calls for a battery pressure of 18 volts.

The ratio between the battery series and relay resistances only

determines the voltages of the track battery. The most economical arrangement is when the battery series is about one third of the relay resistance.

AUTOMATIC TRAIN CONTROL.

Experience has shown it to be desirable that signal control should be exercised directly in the cab of the railway locomotive. The subject is a very controversial one, there being differences of opinion as to the character of the control required and as to the means for effecting communication between the road and the train.

The Great Western Railway has had in use for the last 10 years a fairly extensive installation of automatic train control.

It is recognised that safety in railway locomotion like safety in all other kinds of locomotion is dependent upon a good look-out, and on that account that there should be a minimum of interference with the driver consistent with the object sought to be obtained. This minimum is the indication of the distant signal which it is assumed may be missed by the driver. The Great Western system has accordingly been purposely limited to this signal. It is further considered that the control apparatus should be subservient to the driver, who is and must remain primarily responsible for the running of the train; he may be warned in such a way that his train will be automatically pulled up if he is not taking notice, but when he is alert there must be no question of taking—at perhaps a critical moment—the control of the train out of his hands.

Further views—and these were observed in designing the scheme—are that the operation of the control on the train must be neither dependent upon a movable appliance on the line (on account of the known weakness of movable appliances, particularly mechanically-operated signals) nor upon the positive making of an electric contact.

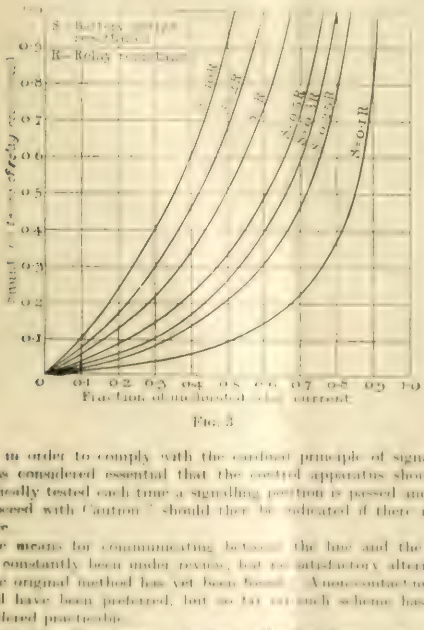


FIG. 3

Also, in order to comply with the cardinal principle of signalling, it was considered essential that the control apparatus should be practically tested each time a signalling position is passed and that "Proceed with Caution" should then be indicated if there is any failure.

The means for communicating between the line and the train have constantly been under review, but no satisfactory alternative to the original method has yet been found. A non-contact method would have been preferred, but so far no such scheme has been considered practicable.

The author then proceeds to give a detailed description of the system, which depends on the de-energisation of the electromagnet controlling the valve admitting air to the train pipe. The essential elements are shown in Fig. 4.

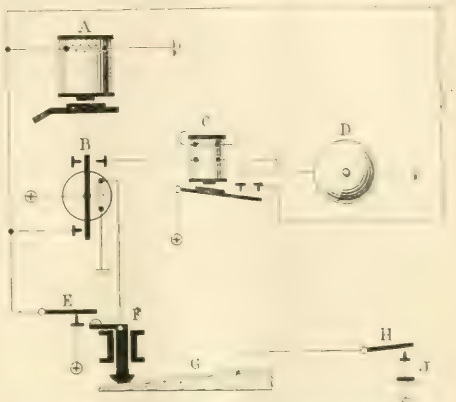
In the case of trains running at high speeds (80 miles per hour and upwards) over a 40 ft. ramp, the period of effective opening of the switch in circuit with the electromagnet may be less than one-fifth second. There has been no [illegible] of the armature release with this period of interruption. [illegible] has been to maintain an [illegible] contact with the ramp during the time the shoe is on it. This has been met by introducing a slow-acting relay [illegible] due to the operation of the [illegible] of the positive battery connected with the mass of the [illegible] to cause the armature of the slow-acting relay to keep the switch [illegible] momentarily open [illegible].

The slow-acting relay also [illegible] current is picked up from the ramp the bell sounds for a definite period.

GRAVITY SHUNTING SIDINGS.

As showing the possibilities of electric operation and control, an ingenious system, the invention of M. [illegible], recently in use at Lumes, on the Eastern Railway of France, is worthy of mention. For simplicity the system is described as applied to the lay-out of sidings (Fig. 5).

A signalman is stationed between the top of the hump and the first pair of points, and he has a number of electrical pushes corresponding to the number of sidings. The number of the siding into



A Valve electro-magnet
B Polarized relay
C Slow-acting relay
D Bell
E Switch opened by lifting of shoe
F Shoe
G Ramp
H Switch at signal box
J Battery at [illegible]
⊕ Positive end of engine battery
Mass of engine and earth
(Negative end of engine battery connected to mass)

FIG. 4

which each wagon (or group of wagons) is required to go is chalked on the front of the wagon. The wagons are pushed up over the hump and then released one after the other to run, spaced a few yards apart, down the grid. As each wagon approaches him, the signalman depresses the push corresponding to the siding required, and without any further attention on his part the points are moved in the necessary order at the proper time.

The track circuits, S1, S2, S3, &c., are provided, S2 between the fouling point of siding I. and the fouling point of siding II., S3 between the fouling points of siding II. and siding III. and S1 the same length as the others in advance of the fouling point of siding I. The points are worked by electric motors with two field windings.

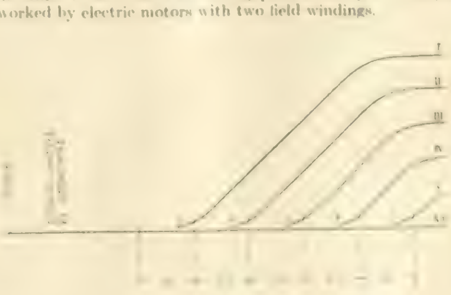


FIG. 5

In conclusion, the author refers to [illegible] for electric signalling purposes, and to the [illegible] of electric signalling methods. A good deal more is [illegible] of electric signalling [illegible]. There is, however, [illegible] the electric power of [illegible] and [illegible].

The Electrician.

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A Plea for Standardisation.

The science of engineering is an open book. What one firm can do another can. No man or group of men to-day possesses a monopoly of knowledge in any branch of engineering. There is only one secret of enduring commercial success—efficiency.

We feel that the present is a very appropriate moment at which to plead for universal consideration of the means that make for engineering efficiency.

The basis of efficiency is economy—the avoidance of waste. To the average Briton economy is an uncongenial comrade—a comrade whom it is intended to cast off after the war. Never was economy more uncongenial than it is to-day, and never more universally recognised as essential. In some things economy may prove less essential after the war than it is to-day, but in engineering it will become ever more and more essential. Success in an art in which many are skilled depends upon little differences. The little differences which are beginning to count more and more in engineering are differences in cost of production, and these depend upon economy in methods and in material.

It has long been recognised that everything an engineer makes should be designed for maximum possible efficiency, but we doubt whether a sufficiently broad view has been taken of the meaning of efficiency. Of two alternative designs for, say, a 5-H.P. motor, the one may have an efficiency of 85 per cent. and the other only 82 per cent.—the term efficiency having the narrow significance of efficiency of working. It is quite possible that the motor of lower working efficiency may be a better commercial proposition than the other; for it may possess a higher overall commercial efficiency.

In its broad sense efficiency is the ratio of the money value of the output of a machine to that of the input, including interest on capital outlay, depreciation, cost of upkeep and attendance and cost of insurance. Among the items of input the interest on first cost is very important. And every manufacturer knows that reduction of first cost can be brought about by standardisation.

For any machine of given specification there must be a best design and a best method of construction, and it [illegible] that to standardise such a design would [illegible]. The wisdom of standardising a design which, although it is the best we know, is certainly not the best possible, is less obvious. Nevertheless, experience has shown that the price of standardisation is ample to [illegible] of design and construction. So keen is competition becoming that we feel it would be wise [illegible] to standardise everything for which [illegible] there is, or can be created. [illegible] standardisation should embrace generators, [illegible] switchboards and measuring instruments instead of being confined as it now [illegible] to [illegible] and fittings.

An important preliminary to standardisation of apparatus is the standardisation of rating and of guarantees. The [illegible] international agreement upon all such matters. At present no country has attained even a domestic agreement. One firm may offer a 60-H.P. motor of given speed and voltage for £200, whilst another asks £300. And it may be that the latter is the cheaper machine, having been designed more liberally and for more conservative temperature rise.

It ought not to be worth the while of any firm either to overrate or to underrate its materials of design, for to overrate is to endanger the firm's good name and to underrate is to do the firm less than justice and to put upon it an unnecessary handicap in competition.

The unwisdom of overrating materials and running too close to allowable limits of temperature rise will hardly be disputed, but not all British firms have yet realised that it is unwise to be over liberal. Instances can be named in which firms exhibit with great pride evidence that their machines have proved capable of carrying indefinitely a load of 50 or 100 per cent. above their rated load. They seem to fail to realise that such evidence is proof of bad design, just as surely as of reliability. At the present stage of high development of electrical theory no firm can afford to exhibit undue liberality in design. If we are to win out in the world competition which lies ahead of us we must be careful first to define our ratings, whether of materials, of component parts, or of finished apparatus, and then to work closely to them. And in defining ratings we ought to insure that the definitions do not put us at a disadvantage as compared with other nations.

In saying that ratings and limits for electrical apparatus have not yet been standardised, we do not lose sight of the good beginning that has been made. Definite suggestions have, for instance, been put forward with regard to temperature rise, and a fair attempt is being made to follow them. But was it wise to fix, as has been done, limits of temperature rise which are distinctly more conservative than those adopted by America and by Germany? In most cases the standard temperature rises chosen by this country are five degrees less than those chosen by America, and by Germany—whose standardisation rules have been taken as a basis for those of most other European states. What grounds has Great Britain for thinking, as her choice of standardisation rules seems to imply that she does think, that she can afford to give points to other countries?

It is not sufficient to reply that Britain's more conservative limits of rating will insure for her goods a better name for reliability. The limits chosen by America are being successfully used. They suffice, they give greater economy and they conduce, therefore, to better design.

The points in favour of standardisation of engineering products are so obvious as hardly to need enumeration. Many things may, on the other hand, be urged against it. For example, it is said that standardisation is stagnation. To standardise a design is to standardise its faults as well as its virtues. These are pertinent criticisms and ought always to be kept in mind. But would they be urged, for instance, against the standardised form of the modern bicycle or of the clock or watch? If not, why should they be urged against those forms of electrical apparatus which are almost as universally used and certainly as well understood as the bicycle and the clock?

It would, doubtless, be unwise to standardise certain classes of electrical apparatus as, for instance, single-phase or polyphase commutator motors, rectifiers, lightning arresters, arc lamps or mercury vapour lamps, since these can hardly be said to have passed the experimental stage. Similarly, to take an example from mechanical engineering, it is very dangerous to endeavour to standardise

aeroplanes or even motor cars, though much might be done in standardising components parts, as well as tools and methods of manufacture.

Could not something be done immediately towards the standardisation of speeds and outputs of electric motors, with great advantage to the industry? This should really not be more difficult than the standardisation of steel girders, and would have equally beneficial results.

An important advantage of standardisation, likely perhaps to be overlooked, would be the deterrent effect it would have upon the indulgence of fads. A man in want of an electrical machine would specify the work the machine was required to do; this and no more. The manufacturer, bound by well-tried standardisation rules, would deliver a machine properly adapted to the work. It might be a machine having, say, cast-iron slip rings or enamelled wire—the thought of which would shock the old practitioner brought up on brass and cotton—but it would do its work, and the cost of special drawings and development and long wordy specifications would be saved.

Report of the Coal Conservation Sub-Committee.

This report, of which we published an abstract in our issue of the 28th ult., is of particular interest to municipal engineers, and we, therefore, have pleasure in giving below some further opinions of engineers prominently connected with electricity supply.

Mr. R. A. Chattock.

Mr. R. A. Chattock, city electrical engineer of Birmingham, writes as follows:

The publication of the interim report of the Coal Conservation Sub-committee will be very valuable, not only to the engineers who are at present considering the development of their electrical undertakings, but also to the public to whom the report gives a general idea of the lines upon which that development may be expected to proceed.

It is regrettable that this report was not made public when it was first drawn up, as I feel sure it would have prevented a considerable amount of wild talk that has undoubtedly sprung from a somewhat unintelligent anticipation of the report in question.

With the general conclusions of the report I am in agreement, and I am very glad to see that the suggestion to gasify fuel, so that the by-products can be extracted, with the intention that the resulting gas shall be used for the production of electrical energy, is made contingent upon the methods adopted being perfected.

I consider that at the present time a large expenditure upon processes of this kind would not be justified, but that it will be necessary to carry out further experiments on a fairly large scale before a definite decision can be arrived at.

The idea is a very attractive one, and there is every indication that it will be developed, and prove to be a very valuable asset to the country, but it is obviously unwise to proceed until the process has justified itself.

It must not be forgotten that what may be best from a national point of view may not, on the other hand, be to the advantage of the electric supply industry. The enormous business that will be set up [illegible]

[illegible]

The report mentions the necessity for [illegible] distributing centres.

In certain parts of the country, notably in the Midlands area, there are no important waterways capable of supplying water sufficient for the requirements of a large super-station, and these electric roads would have to be of very great length. The cost of transmitting large bulk supplies of electrical energy along these roads will be a very material factor in the general cost of supply, and in some instances will undoubtedly exceed the saving that can be effected by using unlimited cold water for condensing purposes.

It would, therefore, be desirable to very carefully consider what local natural facilities are available in each district, with a view to utilising these as far as possible should they be found to give as great or greater economy than a scheme involving a long transmission line.

The Board of Electricity Commissioners that is recommended for appointment would be an ideal body for deciding matters of this kind which would entail very careful investigation involving highly technical knowledge in connection with the generation supply and distribution of electrical energy.

I strongly endorse the hope expressed in your leader that the report of the Board of Trade Electric Power Supply Committee will be issued in the near future. It would be very unfortunate if the large schemes that are now occupying the attention of electric supply engineers are allowed to proceed along lines which it would be difficult to co-ordinate later on; the industry wants a lead from the Board of Trade, and requires this as soon as possible.

Mr. C. Nelson Hefford.

Mr. C. Nelson Hefford, manager of the Leeds Electricity Department, writes as follows:—

The report recently published of the above Sub-committee justifies its investigation by the admitted necessity of providing an ample and cheap supply of power. It further advances by stating as a fact the superiority of the electric drive on grounds of economy, and it then concerns itself with the most economical methods of providing the electricity necessary for the electric drive. On sound general grounds it advocates the centralisation of production, but an examination into the degree of centralisation desirable does not appear in the report, although for reasons no doubt satisfactory to the authors conclusions are reached necessitating an enormous extension of the centralisation idea.

It would appear that the gap between the degree of centralisation already attained and that suggested is so great that engineers who are possessed of any caution at all would pause and endeavour to obtain much more reliable information than is at present available before accepting as necessarily accurate the findings of the report. This is, I think, specially so, as unfortunately the authors have descended from the high ideals put forward in the earlier portions of the report, to an altogether less important matter; namely, that of demonstrating the superiority or otherwise of private against public control of electric generating stations.

I do not think any power company's engineer would be prepared to state that certain apparatus in a certain locality would require more coal for every horse-power hour consumed by customers if the engineer happened to be a municipal engineer rather than a company engineer, and I am quite sure that no municipal engineer would be prepared to say the converse.

It is, I think, suggested that the whole energy required by the new industries which it is hoped to attract to this country [illegible] without any increase in the consumption of fuel by the adoption of the recommendations of the report. [illegible] have been obtained by the introduction of the large scheme of electrical supply and distribution on the North-East coast. Such [illegible]

[illegible]

I have been for some considerable time endeavouring to ascertain what would actually be the advantage to the city of Leeds if it were able to draw a very considerable amount of its electricity from some huge power station capable of using the highest developed type of generating apparatus, and situated possibly more favourably for coal and condensing water than may be the case here when this undertaking has considerably increased in size. The first difficulty which I have met is that I have not yet been able to obtain from any reliable source at what cost it is hoped electricity will be generated at one of these stations. I find this closely followed by the difficulty in obtaining an estimate for the cost of transmitting such energy from the works to Leeds. There is also another difficulty in that apparently whatever economy can be obtained in a super-station similar economy reduced in only a slight degree can be obtained in a station of much more modest dimensions.

Our large industrial centres have, generally speaking, their electricity organisation, whether municipal or company controlled, under the guidance of able and progressive engineers, who have been fully aware of the advances that might be made in the scientific world with reference to power production generally, and I think, in view of the publicity that has been given to the report of the Sub-committee in the daily Press, it is due to those engineers to make it clear that the suggestions contained in the report of the Sub-committee are not based on some wonderful discovery made by that body. Excepting in the cases of stations erected more recently than any large municipal station, it can, I think, be argued that the municipal stations are at least the equal of the company stations in the advantages they have taken of such developments as had been made at the time of their conception.

No doubt such policy will be continued, and, in the case of cities of large size, any advantages which would occur from the use of by-product recovery plants in connection with electric generating stations will be carefully considered quite apart from any question as to ownership. Such an opportunity will arise in the city of Leeds within a comparatively few years, which adds to my difficulty in finding any advantage that would accrue to the city by obtaining its supply from the super-station.

To obtain a true appreciation of the value of the report it is necessary to make a determined effort to ignore the uncalled-for comparisons between company and public controlled concerns. Neither of these categories has done anything so distinctive on the lines of the report as to justify any comparisons at all.

A new ideal is put before us, without, it must be confessed, any very substantial grounds, but if on local investigation conclusions in its favour are arrived at it becomes almost a matter of detail as to its carrying out. Summarising the report, in so far as it really matters, we are to believe that for economical generation, very large power stations are necessary with large units and suitable facilities for obtaining coal and condensing water. Scientific research also indicates the wisdom of providing for the installation of by-product recovery plant. That surely is the whole matter so far as the Coal Conservation Sub-committee is concerned.

The incentive to adopt the report and act on it when possible will lie in the self-interest of sections of the community, and the necessity of satisfying the Government Departments concerned of the desire to adopt the most advanced scientific methods practicable.

Assuming the findings of the report on the above points generally correct, it then is desirable to see how existing authorities can be [illegible] in obtaining their [illegible]. Companies and municipalities have done an enormous work in connection with the supply of electricity, and great as the anticipated growth may be I doubt if the dealing with it will be a matter of any greater difficulty than has been already successfully overcome. The replacement of reciprocating engines of small capacity by turbine-driven machinery of [illegible]

[illegible]

both municipal and company) that no additional generating stations shall be constructed other than of a joint character.

The site or sites for such stations will be chosen and the possibilities of extension in existing stations and also the necessity of extinction agreed upon. A comprehensive scheme of linking up can then be designed, always having in view the ultimate supplying to existing stations from the eventually to be erected large works. If a site is then available in this area capable of accommodating a large power station on the lines indicated in the report, the various authorities should agree to construct such a station jointly, and undertake to draw from it a certain definite amount of energy between stated hours. It would appear that by some such scheme large units could be installed from the very start, and directly they are in commission they could be loaded up to their full capacity and the utmost economy obtained so far as the new works was concerned. This, of course, would react unfavourably on the older works, but their function would be to deal with the surplus load and growth of the undertakings, until such growth justified further extension at the combined power station and provide spare plant.

It will be, however, absolutely necessary to demonstrate to the larger municipalities that participation in such a scheme will be to their ultimate benefit, and certainly at the moment this appears to be a matter of great difficulty. Put very crudely, it will be very difficult to pursuade the ratepayer of the large municipality of the advantages of a scheme which reduces the cost of electricity very considerably to his competitor at some smaller centre without in any appreciable degree affecting his own costs.

It might be urged that this is one of the reasons which make it difficult for public ownership to be considered seriously in connection with such a scheme, but public ownership already exists, and is going to be affected one way or another. Large amounts of capital have been expended on electrical undertakings by municipalities and companies, and in consequence, large amounts of money have been paid into sinking or reserve funds, and in the course of the next few years, a tremendous amount of debt will be extinguished.

The public of existing local authorities are entitled to utilise to the full any advantages that the repayment of this money brings, and one of the incentives for the investing of public money in electricity undertakings was the competition between industrial centres for the obtaining of new industries in their midst. Authorities whose policy has been one of maintaining electricity works in a state of economy and efficiency, are entitled to the advantage such a policy will have given them over less far-seeing districts, and they cannot be expected to favour with great enthusiasm a scheme which openly asserts the possibility of new towns springing up round the super-power stations, and attracting away from the older boroughs large businesses which have caused municipalities to spend large sums of money in the provision of roads, tramways, sewage, water, gas and electricity schemes to provide facilities for the workpeople engaged in industry.

It would appear that the only way in which such support could be justified would be to make each authority benefit not only on account of the increased economy of the super-power scheme, but also by virtue of past policy, and the suggestion of part ownership makes this possible in that each authority would be a shareholder in the big power station, participating in any profits it made, such participation being placed to the credit of the subscribing electrical undertaking, and enabling it to affect its local prices accordingly. At the same time local prices would still be affected by such policy as had been pursued in time past and advantage of setting price could be retained, though probably the amount of difference would be reduced.

I am strongly of opinion that whatever advantages are to be obtained will be much more easily arrived at by some such scheme of co-operation than by a method of wholesale extinctions, which includes good, bad, and indifferent, and would enable public money to be used efficiently and much more justifiably than if the scheme were placed under private ownership or even removed from local control.

Mr. T. Roles.

Mr. T. Roles, city electrical engineer of Bradford, does not think (according to an account in the "Yorkshire Observer") that the location of a power station on a waterway is so important as location near the centre of distribution. For example, in the case of Bradford the nearest site fully meeting the requirements of the report would be in the neighbourhood of Pontefract. This, however, would involve transmission at 30,000-60,000 volts and the losses would be considerable. At present the Bradford works can claim a consumption of coal per unit generated as low as, or lower than, that of any other works in Yorkshire, although a number of these other works are situated on important streams. On the other hand, Mr. Roles admits that the Bradford site is unsuitable for developing [illegible] in the immediate vicinity, or for the extraction of by-products from coal. The estimates of saving

coal in the report are based on the present consumption of coal throughout the country, averaging 5 lb. per indicated horse-power hour. Mr. Roles thinks that this figure is too high. In the case of a number of mills with which he is acquainted, having a total horse-power of over 28,000, the average consumption of coal per indicated horse-power hour is only 2 lb. The whole financial question should be considered very carefully, as the conservation of capital is quite as important as the conservation of coal at the present time. In the report there is no indication of the capital cost of the scheme, or the cost of buying out existing undertakings. Mr. Roles thinks that the arrangement of a number of the proposed super-stations might be started immediately after the war, but he is not convinced that the wholesale scrapping of existing works, as appears to be suggested in the report, is necessary or desirable. Mr. Roles thinks that the controlling authority should not control the main distribution, but only the generation and transmission, and that the authority should consist of a Board representing all interests, both company and local authority.

Correspondence.

SCIENTIFIC COSTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In considering the problems that will confront the British manufacturer when hostilities cease, it should be more generally recognised that the question of scientific costing is undoubtedly one of the greatest importance.

The subject is little understood by many manufacturers, and it is appalling to note the methods that some use to cost their products. They have no certain knowledge that any particular article is returning them either a profit or a loss (if the line happens to be sold at a competitive price), and are quite content as long as the balance sheet for the year's trading shows them a profit on the total turnover. On account of this, business is quite unknowingly spoilt both for themselves and for others in the trade, and quite a lot of "cutting" is not due to any desire to sell at unprofitable prices but to ignorance of the exact cost incurred in producing a given article and the proportionate amount of "overhead charges" the article should legitimately carry.

Anyone who has studied the subject from a scientific point of view has only to make a few casual inquiries from acquaintances who are manufacturers in the hardware trade to become painfully aware that my remarks are only too true. A firm will pay a great deal of attention and spare no expense in organising their plant to a high degree of perfection, but when it comes to the real study of a costing system suited to their business, well, they simply do not trouble.

Why is this? Is it because of the apathy of the manufacturers or of the accountants who audit their books? I make no definite pronouncement, but I imagine that the fault lies with both, but the root of the trouble is undoubtedly to be traced to the manufacturers in not making a study of the science themselves and not demanding a more up-to-date service from the accounting profession. Can it be that many manufacturers fight shy of the additional amount of record keeping that is necessary and of the consequent "mild upheaval" of their old time methods in order to make it possible to obtain valuable data for the conduct of a business on scientific lines? I somehow fear this is the case, and because of this the whole subject even when taken up is dropped in its early stages with a shake of the head and remarks about "new-fangled notions costing more than they are worth."

To install a sound costing system in a factory making a variety of products requires a vast amount of close study, preferably by a member of the firm who knows all the details and inner workings of the business from "A" to "Z," and this person should collaborate with a good firm of up-to-date accountants who have made a special study of works organisation and costing. If this be done some valuable results will be obtained, but it must be at once recognised that no accountant living will be able to walk into a works, and after making a few weeks' study, install a scheme that could be considered anything near finality. The accountant studies the subject along the lines laid out by certain defined principles, but the methods of applying these principles will be found to require considerable ingenuity, and for this reason it is so necessary for the subject to be studied closely in all its aspects by one closely connected with the firm, who will devote the time and has the initiative to work out methods suitable to all departments of the factory so that the necessary statistics and data can be properly collected.

A fact that is not generally recognised by those whose cost finding methods are somewhat ancient, is that it is quite impossible to evolve and apply a satisfactory costing system without first organising every department of the factory. To obtain cost records that are both reliable and valuable, there will have to be a certain amount of departmentalising in the various classes of work and a re-grouping of every bit of effort expended within the walls of the factory. Productive wages must be departmentalised as will also non-productive wages, whilst all items of expense must be allocated to their proper positions and a strong line of demarcation drawn between the expenses for one department and those of another instead of jumbling them all together, as is so often the case. It will readily be seen that it is impossible to obtain records unless this be done, and no firm desirous of organising their costings must expect it to be a matter of a few weeks' work. It will take at least six or twelve months in the case of an already established firm, because so many customs and methods of working both in office, warehouse and works have to be entirely superseded before new methods are adopted. The process of destruction has to take place before construction can commence, and this is the one very great reason why manufacturers hesitate long before making the final plunge to cast out methods that have become thoroughly ingrained into every person on the premises.

In conclusion, let me say that although in the first place the organisation of the factory will have been undertaken in order to obtain a satisfactory costing system, it will be found in a few years' time, the new conditions under which it has been necessary to work every department, and the records and data obtained, will be actually of more use than the costing system itself. By this I mean that a year or two after changing over from grandfather's methods of costing to the 1918 methods, a manufacturer would come to the conclusion that he would rather go back to his old rule-of-thumb method of costing, obtaining his records, perhaps, yearly from his hastily prepared trading account, than give up the new methods of administration and organisation he has built up in his works and go back to the chaotic conditions that appertained in his factory beforehand; which means that besides accomplishing what he sets himself out for, the manufacturer has gained other advantages far greater.

A knowledge of costing (as a correct science, as I have stated) allows those works that acquire it to exercise a closeness and continuity of self-criticism that is impossible without it. Surely one cannot say more? I am, &c.,

Birmingham, Jan. 2. HOWARD [illegible] SMITH.

PRODUCTION OF DUCTILE TUNGSTEN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to the criticism from the British Thomson-Houston Co. in your last issue on my recent lecture, I beg to state that I was not misinformed regarding the production of ductile tungsten filaments before the war. The statement made at the lecture was to the effect that before the war ductile tungsten filaments were not being produced on a commercial scale in this country from the ore. This fact is ably supported by the statements in the letter from the B.T.H. Co.

The final stages in the manufacture of the filaments were certainly carried out in this country before the war, but, so far as I could ascertain, no firm was at that time manufacturing ductile tungsten filaments from tungsten ore. The imported manufactured products, which were at that time used by the various firms as the starting point, were pure tungsten oxide or tungsten rod.

It would appear from their own statement that the B.T.H. Co. had to devote at least a year to investigation before they could bridge the gap between tungsten ore and their previous starting point.—Yours faithfully, &c.

New Barnet, Jan. 1. STUART [illegible]

Legal Intelligence.

Liability for Accidents on Unlighted Stairs.

In the Glasgow Sheriff Court last week, Sheriff Craigie dismissed an action by Mrs. A. MacGuire against the Corporation of Glasgow for damages in respect of injuries sustained by her on Feb. 25 through falling down the stairs at premises where she resided.

Pursuer stated that one of her children took suddenly ill, and she was going downstairs to procure medicine when the accident occurred.

The SHERIFF said it seemed to him that the case was ruled by the recent decision in Baikie *v.* Corporation of Glasgow. In the Baikie case Lord Skerrington, who dissented from the majority of the Court, said, in referring to the judgment in Driscoll *v* Commissioners of Partick, the judgment in that case implied in his opinion that the pursuer had acted negligently in the circumstances as explained by herself. It might have been different if she had explained that she left her house and hurried downstairs on receipt of a message that her child had been run over in the street." The averments made by pursuer in the present case came near to, but did not quite reach the circumstances imagined by Lord Skerrington. Be that as it might, it seemed to him that if a person, for even a laudable object, hurried down or up a stair of a tenement which the Corporation had failed to light according to their statutory duties, and thereby hurt himself or herself, then he or she could not, unless under very special circumstances, get compensation for any injury that might [illegible].

Patent Record.

SPECIFICATIONS PUBLISHED.

The [illegible] from [illegible] of the specifications recently published have been [illegible] Messrs. Marks & Clerk, Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.

[illegible] on which the application was lodged at the Patent Office the former is given in brackets after the title.

[illegible]

5.300 CARBONE, T. L. Electric arc lamps. (11 4 16.) 111,115.
[illegible]
11.564 TURNER, A. Electric metallurgical furnaces. (16 8 16.) 111,120.
12.168 TIETGEN, H. Insulation of electric cables. (28 8 16.) 111,496.
[illegible] (30 8 16.) 111,497.

[illegible] transformation from three-phase to two-phase alternating current or vice versa, one winding of each of said transformers being dividedinto two or more sections, and each section subdivided into a plurality of coils, the convolutions of each coil varying according to a determinable law, a coil on one core being connected in series with a coil on the other core according to the said law, the said two coils being connected to a segment of the commutator, the width of said segment varying according to a law dependent on the ratio of the convolutions of the aforesaid coils.

12 985 PUPIN, M. I. Art of electrical tuning. (17 9/15.) 101,540.

A method of compensating the energy losses in an electrical conductor of periodically varying electrical waves, which consists in placing said conductor in electromagnetic interaction with a source of energy which transfers electrical energy to the [illegible] ting in the conductor a negative resistance reaction of high value [illegible] the original resistance reaction in the conductor, so that the [illegible] of the conductor is reduced from any given high value to a pre- [illegible]

15 137 WHEELER, F. C. Electrolytic cells. (30 10/15.) 102,049.

[illegible]

[illegible] OLDHAM, O. Miners' electric safety lamps. (17 11 16.) 111,165.

[illegible]

[illegible] SIMPSON, F. C. Radio telegraph and telephone stations. (22/11/16.) 111,332.

[illegible]

[illegible] Electric motor controller [illegible]

17.702 LANGFORD, J. S. Electric ovens, hot cupboards, and the like. (14/1/16.) 103,476.
17.820 RIVIERE, A. D., & SOC. CENTRALE D'ENTERPRISES A. D. RIVIERE ET CIE. Electro-magnet for lifting materials. (11 12 16.) 111,554.
18.323 WESTINGHOUSE METAL FILAMENT LAMP CO. (Westinghouse Lamp Co.) Manufacture of filaments for incandescent electric lamps. (21 12 16.) 111,569.
18.398 HOGAN, G. R. & MACLAGAN, H. P. X-ray apparatus. (22/12/16. 111,570.
[illegible] SITES, E. F. Electrical heating apparatus for permanently waving hair on the head. (28/12/16.) 111,372.

1917 SPECIFICATIONS.

80 B. T.-H. CO. (G. E. CO.) Systems of ship propulsion. (2/1 17.) 111,574.
180 M. L. MAGNETO SYNDICATE, LISTER, G. A., & WATSON, E. A. Magneto-electric machines. (4/1/17.) 111,373.
255 MURRAY, T. E. Process of electric welding. (18/2/16.) 104.500
609 LONGFORD, H. G., LONGFORD, W. W., & CLARK, W. A. Ignition plugs. (12/1/17.) 111 198.
788 HUMPHRIES, W. L. Carbon holders of electric arc lamps. (16/1/17.) 111,382
860 HENRY, H. D. Electric batteries. (17/1/17.) 111,383.
1.307 HARRISON, H. H., & CREED & CO. Strip perforating mechanism for code telegraphy. (25/1/17.) 111.581.
1.491 GILBERT CO., A. C. Toy electric motor installation. (18 4 16.) 105.743.
1.577 VILLIERS ENGINEERING CO., FUNCK, G., & FARRER, F. H. Magneto devices for internal combustion engines. (31/1/17.) 111.391.
1.661 HEARSON, C. E. Electric furnaces. (1/2/17.) 111,207.
1.880 ARNOLD, C. F. Spark plugs. (7/2/16.) 104.334.
[illegible] PICKERSGILL, W., & PITT, J. H. Trolley heads [illegible] 111.396.
2.621 PECKHAM, E. Electrical massage appliances. (4/7 17.) 111,399.
3.268 IGNITION CO. K. W. Impulse starting mechanisms for the ignition magnetos of internal combustion engines. (15/3 16.) 105.328.
3.916 STERLING TELEPHONE & ELECTRIC CO., BELL, F. G., & DAVEY, W.C. Elec. bells. (17/3/17.) 111,609.
4.637 MUTTO, O. Interrupter mechanism for electric circuits. (30 3 17.) 111,414.
5.246 SCHAANNING, A., & THOMPSON, J. L. Tanks for electrical transformers. (13/4/17 111,621.
5.301 BRITISH WESTINGHOUSE ELECTRIC & MANUFACTURING CO. (Westinghouse Electric & Manufacturing Co.) Control [illegible] (14 4 17.) 111 623.
5.358 TWISS, G. V., & BULLERS, LTD. Electrical insulators. (16 4 17.) 111,624.
5.365 GRAHAM, E. A., & RICKETS, W. J. Thermal electric relays and circuit controllers (16 4 17.) 111,420
[illegible] AMES, A. [illegible] (6 12 16. Div [illegible]) 111.628.
5.644 WILKINSON, H. T., & WARDLE ENGINEERING CO. Lanterns or casings for incandescent electric lamps. (23/4/17.) 111.629.
[illegible] ELECTRIC CO. Cutler-Hammer Manufacturing [illegible] (25/5 17.) 111.246.
9.017 GUINNESS, K. E. L. Sparking plugs for ignition purposes. (22/6/17.) 111.255.
9.108 ATHERTON, J. Electric signalling devices. (25/6/17.) 111.640.
9.165 TURNER, W. V. Electro pneumatic brake system. (6/12 16.) 111.439.
9.321 GUINNESS, K. E. L. Sparking plugs for ignition purposes. (28.6/17.) 111.256.
9.470 MIDGLEY, A. H., & VANDERVELL & CO. C. A. Electric switches. (30/6/17.) 111,258.
9.962 WESTERN ELECTRIC CO. (Western Electric Co.) Telephone exchange system. (10/7/17.) 111,261.
10.129 EDISON SWAN ELECTRIC CO. & BIRD, S. S. Electric batteries. (12/7/17.) 111.444.
10.423 BENNETT, C. G. M. Cord grips for electric conductors. (19/7/17.) 111.447.
[illegible] BRITISH WESTINGHOUSE ELECTRIC & MANUFACTURING CO. (Westinghouse Electric & Manufacturing Co.) Electric motor control systems. (3/8/17.) 111.265.
[illegible] KENNINGTON, W. O. [illegible] 111 644.
13.073 WESTERN ELECTRIC CO. (Western Electric Co.) Wireless telegraphy and telephony. 12/9/17. (Addition to 102,503). 111.649.

A method of simultaneous radio telegraphy and telephony which consists in the production of a modulated carrier wave, elimination of the carrier frequency component of said modulated wave, the restoration of a wave of said frequency in accordance with telegraph signals to be transmitted, and the detection of said waves at a receiving station.

14.369 TANNER, H. L. Electric motors. 19/7/16. (Divided application on 15 363/16.) 110,359.
15,901 BROWN, T. H. A. Shade holders for electric lamps. (31 10 17.) 111 653.

Volunteer Notices.

COUNTY OF LONDON VOLUNTEER ENGINEERS

Headquarters: Balderton street, Oxford street, W. 1.

Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.

Orders for the Week.

Officer of the Week.—Sec.-Lieut. H. J. Golding.

Next for Duty.—Lieut. P. Bowden.

Promotion.—Sergt. Hood, H. C. to Sergt. Inst. of Musketry.

Monday, Jan 14.—No. 3 Company, 6.30–8.30. Recruits' Drill, 6.30–8.30. Signalling Section, 6.30–8.30.

Tuesday, Jan 15.—Lecture on Demolitions, 6.30. Physical Drill and Bayonet Fighting, 7.30.

Wednesday, Jan 16.—No. 1 Company Drill, Knotting, &c., 6.30–8.30. Recruits' Drill, 6.30.

Thursday, Jan 17.—No. 2 Company Drill, Knotting, &c., 6.30–8.30. Recruits' Drill, 6.30–8.30. Signalling Section, 6.30–8.30. [illegible] Section, 6.30–8.30.

Friday, Jan 18.—Musketry, 6.30–8.30.

Saturday, Jan 19.—Entrenchments, &c., 2.15–4.15. Recruits' Drill, 2.15–4.15.

[illegible] All drill and parade will be at Headquarters [illegible]

[illegible] are reminded that the range at [illegible] will be done at Headquarters.

No member of the Corps or other person will be allowed in the officers' [illegible] to use the canteen or the gallery during the time the [illegible]

Recruits will [illegible] instruction with the Company.

Commercial Topics.

Electricity in Mines.

Part II. of the Annual Report on Mines and Quarries gives particulars of the electric motors used above and below ground at coal mines. The following is a summary of the horse-power of motors employed:

Division.	Surface.	Underground.	Total.
	H.P.	H.P.	H.P.
Scotland	35,097	124,251	159,348
Northern	97,148	103,996	201,145
York and North Midland	86,718	67,267	153,985
Lancashire, N. Wales & Ireland	17,430	27,222	44,652
South Wales	116,169	114,740	230,910
Midland and Southern	15,281	44,737	60,018
Total in 1916	368,445	482,215	850,661
Total in 1915	336,102	468,628	804,731

The number of electrically driven coal-cutting machines at the end of 1916 was 1,590, an increase of 141 over the number at the end of 1915. During the year 1916 there were 10 fatal accidents at mines due to electricity investigated by H.M. Inspectors of Mines, resulting in 10 deaths; six took place on the surface and four below ground.

At 667 collieries coal-cutting machines were used, against 638 in 1915. The total number of machines enployed was 3,459 (against 3,089), of which 1,590 were worked by electricity and 1,869 by compressed air; the total quantity of mineral obtained in 1916 by the aid of these machines was 26,805,398 tons, an increase of 2,295,274 tons. Nearly 52 per cent. of the total number of machines in use are employed in the Scotland and the York and North Midland Divisions.

The following table shows number of machines, collieries where used, motive power employed, and quantity of mineral obtained during 1916:—

Division.	No. of collieries where machines used.	No. of machines.	Worked by Electricity.	Worked by Compress'd air.	Mineral obtained.
					Tons.
Scotland	232	98[illegible]	841	146	9,764,280
Northern	82	671	159	532	3,778,653
York and North Midland	127	802	387	415	7,739,275
Lancs. N. Wales & Ireland	99	[illegible]	48	521	2,564,620
South Wales	60	136	51	85	650,200
Midland and Southern	67	294	124	170	2,308,310
Total in 1916	667	3,459	1,590	1,869	26,805,398
Total in 1915	638	3,089	1,449	1,640	24,510,124

The following table shows the number of the various types of coal cutters in use and their motive power:—

Number in use.

Kind of machine.	Scotland.	Northern.	York & N. Midland.	Lancs. N. Wales & Ireland.	South Wales.	Midland and Southern.	Total.
Driven by electricity:							
Disc	561	11	[illegible]	11	[illegible]	12	818
Bar	248	21	8[illegible]	31	[illegible]	23	427
Chain	[illegible]	[illegible]	18[illegible]	16	23	67	328
Percussive	3		[illegible]			[illegible]	6
Rotary heading	3	1	[illegible]				11
Total	841	159	387	48	31	124	1,590
Driven by compressed air:							
Disc	100	11	157	[illegible]	[illegible]	11	[illegible]
Bar	1	[illegible]	[illegible]	[illegible]	18	[illegible]	[illegible]
Chain	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Percussive	11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Rotary heading			[illegible]			[illegible]	[illegible]
Total	146	[illegible]	415	[illegible]	[illegible]	170	1,869
Total in 1916	987	[illegible]	[illegible]	[illegible]	[illegible]	294	[illegible]
Total in 1915	908	[illegible]	[illegible]	41[illegible]	[illegible]	[illegible]	[illegible]

The quantity of coal cut by the electrically driven machines in 1916 was [illegible] tons, against [illegible] tons in 1915, and the quantity cut by compressed air machines was [illegible] tons, compared with 10,131,8[illegible] tons.

Commercial Intelligence Organisation.

The Department of Commercial Intelligence has decided to set up local branches in Birmingham, Bradford, Liverpool, Manchester, Sheffield and Glasgow. The branches will work in close co-operation with the local Chambers of Commerce, and will be available for answering inquiries by local firms as to overseas or domestic trade, &c. Confidential information will, however, only be issued direct from the head office of the Department to firms on its special register and to Chambers of Commerce.

* * * *

Canadian Electric Power Development.

The Imperial Trade Correspondent at Toronto (Mr. F. W. Field) recently reported that the Ontario Hydro-Electric Power Commission had in hand preparations for the erection of a large electric generating plant at Chippewa Creek, near Niagara Falls, Ontario.

Hitherto the Commission has been only engaged in transmitting electric power from producing companies at Niagara Falls to [illegible] throughout the Province. It is proposed to construct a canal between Chippewa Creek and Queenstown at an estimated cost of $9,000,000, after which the power-house will be built and the plant installed. The Commission will purchase the equipment and undertake the construction of the plant as a public enterprise. The estimated cost of the equipment is $1,000,000. Among the machinery and materials required are channelers, drills, electric hoists, derricks, locomotive cranes, belting, conveyors, motors and rock crushers.

Mr. Field says it will obviously be of advantage to United Kingdom firms interested in the matter to have a resident agent in Toronto. Tenders are not likely to be invited for any of the plant required, but the Commission desire to purchase the best type of machinery and [illegible]

* * * *

Electric Furnace Progress in Canada.

The Imperial Trade Correspondent at Toronto (Mr. F. W. Field) recently forwarded a copy of the report for 1916 of the Ontario Hydro-Electric Power Commission, from which it appears that during the year under review the Commission had been investigating modern electric furnace practice, and the results show that where power is plentiful and reasonable in price the electric steel furnace is entirely practical.

The increasing number of these furnaces in Ontario confirms this belief, and it is anticipated that the electric furnace will not only be applied to the production of fine steels, but that it will even compete with the open hearth furnace. There is also every indication that electric smelting for iron, copper and other ores will be an important factor in the mining districts of the province. The high prices ruling for coke and coal and for steel products during 1916 made the electric furnace very attractive, and there is every indication that electric steel production in Ontario will grow rapidly during the next year or two. The electrical [illegible]

Electricity Supply.

Extensions.

Belfast.—The Corporation have applied to the L.G. Board for sanction to a loan of [illegible] The loan is required for [illegible] [illegible]

Bradford.—[illegible]

[illegible]

Hackney (London).—[illegible]

Hammersmith (London).—[illegible]

Nottingham.—[illegible]

[illegible]

Swansea. At the meeting of the Electricity Committee last week the chairman [illegible] Sinclair announced that the sanction of the Government had been obtained to the scheme for the extension of the [illegible] plant for supplying current to the docks and [illegible]. The sanction had been given on Priority 4, [illegible] scale for any except direct war work.

Watford. At the [illegible] meeting of the Urban Council the Electric [illegible] Committee submitted a scheme prepared by [illegible] Mr. A. W. Barham for the extension of the electricity undertaking.

[illegible] £18,440 to carry out the scheme. The proposed [illegible] turbo-alternator £10,700, [illegible] £3,000, [illegible] £1,400 [illegible] discharge [illegible] £1,800.

[illegible] the chairman [illegible] said that [illegible] plant had been [illegible], and a [illegible] very dangerous for them to face another winter without more plant. By the new plant they would [illegible] altogether [illegible] £2,000 per annum.

[illegible] approved [illegible] plant were [illegible].

General.

Birmingham. [illegible] the [illegible] Supply Committee formally reported the resignation of Mr. Howard Foulds, the secretary to the department, and recommended that Mr. Ernest John [illegible] be appointed to the office at an annual salary of £800.

The Committee also reported on the development of the electric supply undertaking, and pointed out that in addition to the technical [illegible] upon the time of the [illegible] Mr. R. A. Chattock, there were important negotiations [illegible] Ministry of Munitions and other Government bodies [illegible] in London on many occasions. They were of opinion, therefore, that additional technical assistance should be provided to relieve Mr. Chattock of the detail work involved in the supervision of the generating stations and the distribution system, and [illegible] be authorised to appoint a chief assistant [illegible] at a salary of £750 per annum.

The recommendations were adopted.

Clayton. The Council have rescinded the resolution in favour of supporting the application of the Electrical Distribution of [illegible] for a provisional order, so as to enable them to negotiate with either Bradford Corporation or the Yorkshire Electric Power Supply Co. for a supply of electricity in bulk.

Derby. [illegible] W. G. Wilkins, who presented the report of the Electricity Committee at the meeting of the Corporation last week, [illegible] made to minimise and eventually [illegible] by the frequent failure of the electricity supply.

He said the [illegible] due to the inferior quality of the fuel [illegible] station, but the Committee were in the hands of the [illegible] had a legal remedy he did not think [illegible] it, because it was a well-known fact that [illegible] to meet the enormous demands of the [illegible].

The Ministry of Munitions had [illegible] that the supply of [illegible] to increase, and in order to effect [illegible] those not engaged [illegible] for two hours in the afternoon, the period of greatest pressure. That would involve some inconvenience [illegible] be avoided. Tradesmen [illegible] illuminating shop [illegible] the curtailment of the tramway [illegible] with the installation of new plant [illegible].

In regard to the [illegible] the tramways [illegible] Mr. W. Eaton, [illegible] intimated that on every week [illegible] cut down between 3.30 p.m. and 6 p.m. [illegible] power had [illegible] a loss of £300 [illegible] would mean [illegible] considerable [illegible].

Doncaster. The [illegible] Council has decided to support the application of the Electrical Distribution of Yorkshire [illegible] provisional order [illegible] arranged for [illegible].

Electricians' Demands. [illegible]

[illegible]

tions being allowed to drag on for three months, and a few factories were slightly affected. At the request of the executive of the Union the men, however, resumed work after a brief delay.

The dispute arose in the interpretation of the award, which was at first confined to skilled engineers and moulders on time rates in munition factories, and it was afterwards extended to unskilled workers on time rates whose wages were governed by movements in rates of pay in the engineering and foundry trades. In the case of tramway and electric supply undertakings, it was ruled that repair shops, but not generating stations, would come under the term "engineering trade." The electrical workers were thus excluded, with the result that labourers in the same firms earn more money than skilled electricians.

After lengthy negotiations it was agreed to grant the men's demands and Sir Geo. Askwith's award is as follows:

All plain time working employees in generating stations, sub-stations and on mains directly concerned in the generation and distribution of electrical energy, including the technical staff and, in the case of electrical contractors, employees engaged on munitions work, including the technical staff, shall receive a bonus as follows:

1. All workers who have received not more than 20s. war advance, the equivalent of 12½ per cent. on earnings, any advance given by a pending decision of the Committee on Production, or any advance given by agreement or otherwise, equivalent to the advance of 5s. granted by the Committee on Production to certain trades from the first full pay day in December, to be added as a war advance to the advance already given, and to count as part of the earnings from the date of such advance.

2. All workers who have received over 20s. war advance sufficient to produce the equivalent of the 20s. plus 12½ per cent. on earnings, that is to say, any excess in war advances over 20s., shall merge in the 12½ per cent. on earnings.

3. Workmen who have received the equivalent of 20s. war advance plus 12½ per cent. on earnings, or more, are not affected by this settlement. In calculating whether 20s. has been received it shall be taken as 20s. for the normal week as recognised in the district.

4. Basis rates of wages and conditions of labour shall remain as at present until the withdrawal of war wages and war bonuses.

5. This decision shall take effect as from the beginning of the first full pay the next after Oct. 13, 1917.

Finchley. The Ministry of Munitions has sanctioned the disconnection of electric heating and cooking apparatus, owing to the heavy demand for current at the generating station. To cause as little inconvenience as possible consumers have been requested not to use this type of apparatus during specified hours.

Hampstead (London).—The Borough Council have decided to discontinue the use of the maximum demand system of charging for electric current.

Harrogate.—At its last meeting the Electricity Committee protested against the arbitrary interference with the conduct of the local electricity supply as set forth in the communication from the Ministry of Munitions of Dec. 8, and interpreted by the subsequent correspondence.

Economy in the use of lead for new cables may be desirable, but the use of lead-covered cable already in the local stores might reasonably be left to the discretion of local undertakers. The monthly return of business asked for entails considerable extra work, and, in view of the imperative call for man-power for the direct prosecution of the war, it is difficult to appreciate either the need for such data or how a staff can be found in a Government department to give time and attention to such comparatively minor and unimportant details.

Islington Station Engineers' Salaries.—At the last meeting of the Islington (London) Borough Council it was reported that the award has been issued by the arbitrator appointed in respect of the difference arising out of the application by the Association of Electrical Station Engineers of London on behalf of their members on the technical staff employed in the electrical undertaking of the Council for a war bonus or war wage of 15s., to date from Aug. 1, 1917, and for a 25 per cent. increase on the pre-war (July, 1914) salary to the officers of the technical staff.

The Arbitrator awards 15s. war bonus per week to the members of the technical staff, *i.e.*, to the shift engineers, the mains engineers, draughtsmen, commercial assistant or publicity engineer, junior charge engineers, and mains assistants (including under this term the testing engineers). All war bonuses or war wages given since Aug. 4, 1914, up to August, 1917, merge in the single war bonus of 15s. The war bonus of 15s. per week operates as and from Sept. 1, 1917.

The award states "that, without prejudice to the merits of the claim for an additional 25 per cent. on pre-war salaries, it is undesirable at the present time to decide this issue as between the Association in question and one particular Borough Council."

Linking-up in Lancashire. A sub-committee of the Electricity and Tramways Committee recommends the Council to approve the proposal to link up the electricity undertakings in Lancashire and Cheshire, but to dissent from the scheme to create a joint board to establish and control future and existing power stations and high-pressure transmission lines.

St. Helens.—The salaries of the superintendent of the electricity station, Mr. B. T. Hawkins, and of the assistant engineer, Mr. J. Ward, have been increased by £20 per annum.

Sheffield. Mr. W. M. Myles, analytical chemist to the electric supply department, has undertaken to make analyses of coal samples for the Coal Control Department, for which that department will pay him an honorarium of £50 per annum.

Sheffield and Rotherham Electric Supply.—At a recent meeting of the Joint Sub-Committee with reference to electricity supply to Sheffield and Rotherham, terms were approved for a linking-up scheme to provide for an interchange of supply between Sheffield and Rotherham.

The cost of [illegible] and transformers, together with suitable metering arrangements, [illegible] cost £50,000 [illegible] to be apportioned equally between the two corporations. [illegible] shall be undertaken by [illegible] corporation [illegible] the respective engineers, the total cost per annum being apportioned equally between the two corporations. The supply is to be available for use by either corporation at such times and to such extent as may be agreed from time to time between the respective engineers. All points of difference are to be referred to arbitration. Two generating sets of 20,000 kw. to 25,000 kw. are to be placed on order. The total cost of the scheme will be approximately £1,000,000.

It is proposed to ask the Ministry of Munitions [illegible]

The Treasury has just sanctioned the proposal [illegible] £602,532 [illegible] Sheffield Corporation for a new [illegible]

West Scotland Linking-up Scheme.—Particulars of the report of the West of Scotland Committee [illegible] electricity supply undertakings appeared in a recent issue of the Glasgow Herald.

The area dealt with includes the counties of Renfrew, Clackmannan, Linlithgow and portions of the counties of Lanark, Ayr, Dumbarton and Stirling. The local authorities and companies operating in the area have been arranged in the following four groups:—Group A: Paisley, Greenock and Kilmarnock Corporations, and Kilmalcolm Electric Lighting Co. [illegible]; B: Glasgow Corporation Electricity and Tramways Department and the Clyde Valley Electrical Power Co.; Group C: Alloa, Falkirk and Stirling Corporations, the National Electric Construction Co. (Bo'ness) and Scottish Central Electric Power Co., near Falkirk; and Group D: [illegible] Tramways, Motherwell and Hamilton Corporations, and Lanarkshire County Council (Cambuslang).

In addition to the above corporations and companies many towns in the various counties receive supplies from these centres, and there are also some private plants.

In group A the approximate units generated per annum are 36,070,000, coal used, 59,513 tons [illegible] £41,054 [illegible] average lb. coal per unit generated 3.6 lb.; average price per ton 14s. 9d. To make the most effective use [illegible] it would be necessary to provide a link of 3,000 kw. capacity between Greenock and Paisley, and a link of 1,875 kw. [illegible] Kilmarnock, the latter being linked via Paisley. The total cost of cables, transformers and switchgear [illegible] would be approximately £75,000. On the assumption that Paisley and Kilmarnock were shut down [illegible] and that during the week the supply would be interchanged in the most advantageous manner, the resultant fuel economy would be £5,900 per annum [illegible] reduction of 0.4 lb. per unit generated [illegible] Omitting Kilmarnock and considering only the link between Greenock and Paisley, the annual saving would be £5,200 [illegible] expenditure of £47,200. Further reduction would occur [illegible] due to reduction of stand-by plant [illegible] and it would be at least five years before any [illegible] could be expected from the linking up.

The approximate units generated by Group B [illegible] 281,000,000 [illegible] coal used, 376,[illegible] tons [illegible] £[illegible] average [illegible] per unit, 3.0 lb.; per ton [illegible] The three undertakings [illegible] supplies at a periodicity of 25 cycles [illegible] linked up to some extent, and the committee have been informed [illegible] that it is only necessary to install [illegible] 1,000 kw. [illegible] transformer [illegible] Kilmarnock [illegible] Glasgow Corporation to provide a link of maximum utility at a cost of about £16,000. Assuming that full advantage is made of the inter-connection between the three, and allowing a small average [illegible] of coal per unit generated, the annual saving would be approximately £10,000.

Group C generated about [illegible] units; coal used, 32,845 tons [illegible] average coal per unit 4.4 lb.; per ton 14s. 8d. All the undertakings generate direct current with the exception of the Scottish Central Co., whose [illegible] 50 cycles, and a portion of Falkirk Corporation supply, which is [illegible] The only feasible manner [illegible] would be [illegible] by making use of the Scottish Central [illegible] them to each of the systems. [illegible] maximum load of the whole does not exceed 7,000 kw. [illegible] the Scottish Central, while for the greater part of the week-end the combined load is about 1,000 kw. [illegible] the Scottish Central. The week-end load of the whole of the [illegible] by the Scottish Central, enabling Stirling, Falkirk, Alloa and [illegible] to be shut down during the period of the [illegible] The necessary cables, transformers, rotary machinery [illegible] would involve an expenditure of about £16,000 [illegible]

the five undertakings [illegible] and the committee believe that an annual saving of £1,000 would be realised by linking up.

Group D generate 8,985,000 units; the coals used amount to 21,754 tons; coal costs, £13,031; average coal used per unit, 5.4 lb.; price per ton 12s. The four undertakings generate direct current. Their maximum loads occur practically at the same time and it would not be possible, with existing plant, to carry the combined week-end load on any one station. The expense of heavy direct-current cables which would be necessary linking them up would not, therefore, be justified either for inter-change of supply or for week-end running, but future requirements should be met by high-tension bulk supply.

In addition, the question of linking-up between groups has also been considered and the following conclusions arrived at:—Group E (A and B)—The only practical manner in which these groups might be linked up would be by means of a link between the Clyde Valley Co. (25 periods) and Paisley (50 periods). Calculating on a link of 1,000 kw. capacity, the total cost of mains, rotary machinery, &c., would be approximately £12,870, while the annual saving would not exceed £1,040.

Group F (B and D).—The undertakings in Group D are all within the Clyde Valley area and the Lanarkshire tramways are already supplied from the Clyde Valley Co. at several points. Linking up these groups would involve the extension of the Clyde Valley mains to each of the undertakings in Group D, and the provision of rotary machinery and switchgear would cost £15,000. [illegible] week-ends, the fuel saving would be equivalent to £1,200 per annum. There would be other advantages, but the committee consider that linking up for the single purpose of week-end supply to the stations in Group D from the Clyde Valley Co. cannot in the meantime be recommended.

Group G (B and C).—The linking up in these two groups resolves itself into a question of inter-connecting the Clyde Valley system (25 cycles) with the Scottish Central (50 cycles). Having regard to the distance between the systems and more particularly to the difference in periodicity, necessitating rotary machinery at a new station and special staff, linking up is not recommended. The Scottish Central system, however, is of the same periodicity as the Fife Power Co., whose area of supply is included in the East of Scotland area in the map issued by the National Electric Power Supply Joint Committee, and it is therefore suggested that the district served by these two undertakings would be better considered as a separate area, making three areas in the Scottish section.

Reviewing the subject of inter-connection as a whole, the committee have come to the conclusion that financial benefit would be derived from linking up, for the purpose of interchange of energy, between several of the undertakings in the West of Scotland area. The cost of providing links of maximum utility under existing conditions between the various undertakings is as follow:—Group A, £75,000; Group B, £16,000; Group C, £16,000; Group D, no linking up, all being d.c. undertakings; Group E, £12,870; Group F, £15,000; total £134,870. The annual saving to be anticipated is approximately:—Group A, £5,900; Group B, £10,000; Group C, £1,000; Group E, £1,040; Group F, £1,200; total £19,140; or, omitting the capital and saving involved in Group B, the total capital involved in linking up would be £118,870, and the estimated saving £9,140 per annum. Much greater fuel economy would be realised by linking up where conditions are favourable for the purpose of a supply in bulk from the larger to the smaller undertakings, and the committee [illegible]

Electric Traction.

City & South London Railway.—[illegible] the Board of Trade to extend the time limited for constructing the works authorised by the City & South London Railway Act, 1913, for one year from Aug. 15, 1918. Objections [illegible] Board of Trade by June 28.

Clitheroe.—At the recent meeting of Clitheroe [illegible] plans of a proposed light railway from [illegible] to Hellifield were submitted and received [illegible] The railway would connect villages at present 10 miles or more from a railway station.

Derby.—[illegible] service has been curtailed [illegible]

Grimsby.—[illegible] in 1921, the Corporation has appointed a special committee to consider the question of acquiring the undertaking.

Hull.—On Tuesday the Corporation authorised the Tramways Committee to employ women as tram-car drivers [illegible]

Tramway Control Committee.—Mr. J. Dalrymple, manager of Glasgow Corporation Tramways, has been appointed the Scottish representative on the committee.

Imperial Notes.

Australasia.—It is reported that a large discovery [illegible] has been made in the [illegible] New South Wales, with a reef from 3 ft. to 4 ft. 6 in. wide.

There was a profit of £18,[illegible] on the Australian [illegible] for the past year, compared with a loss of [illegible] the previous year.

The first report of the [illegible] of the Victorian Railways [illegible] from 1914 [illegible]

record gross revenue and a record revenue per train mile. The Commissioners are of opinion that, having regard to the present abnormal conditions, the railways are administered with due regard to economy, efficiency and the public convenience, and that the deficits have been largely brought about by influences beyond the control of the Railway Commissioners. It is proposed to suspend the construction of new railways and the reduction to the lowest limit of expenditure on lines in course of construction.

Control of Canadian Electrical Energy.—The Dominion Government have appointed a Controller of the distribution of electrical energy by electric power companies in the Province of Ontario. The Controller is to determine priority in the supply of energy, and to take steps to ensure that the requirements of certain works are adequately met.

Foreign Notes.

Argentina.—The balance-sheet of the Compania Alemana Transatlantica de Electricidad for the year ended December, 1916, shows a profit for the year of $2,664,318 (gold), which was applied as follows: 5 per cent. dividend and 2 per cent. additional dividend on ordinary shares absorbed $2,074,074, and 6 per cent. dividend on preference shares £444,444. The proportion due to directors in Berlin was $44,604, and $101,196 was carried forward.

Registration of Trade Marks.—The Ministry of Justice and Public Instruction recently decided that in future all insertions in "Boletin Oficial" of applications for trade marks must be paid for in advance. This is in accordance with the Argentine Trade Mark Law (No. 3,975), but the charge has not been enforced hitherto.

Austria-Hungary.—The "Pester Lloyd" recently stated that some manufacturers decided to establish new works for the manufacture of aluminium in the Hungarian county of Bereg. The metal is to be manufactured from alunite under a new patent, and the erection of the works is to be commenced shortly.

Japan.—The Japanese Department of Agriculture and Commerce has drawn up a scheme for the encouragement of inventors and scientists in Japan.

Under this scheme a sum of money will be devoted to the manufacture of models, the conduct of experiments, the provision of lectures and the grant of prizes for inventions and to rewarding notable inventors. The Department will also give financial assistance to promoters of exhibitions [illegible]

Miscellaneous.

Leeds Automatic Telephone Exchange.—The equipment of this automatic telephone exchange is making steady progress, and it is anticipated that it will be ready for opening in April.

Presentation.—At a luncheon of the chief officials of the Corporation on the 31st ult., the Lord Mayor (Ald. Brooks) presented a silver table centre to Mr. Howard Foulds, who recently resigned from the position of [illegible] to the Electric supply department.

The Lord Mayor referred to the ability and geniality of Mr. Foulds.

A [illegible] and a cigarette box were also given by the [illegible] of the [illegible] supply department.

Retirement of a Popular Railway Secretary.—Mr. Oliver Stanbrooke [illegible] after 40 years' service with the Great Central Railway Co., for 25 of which he has filled the responsible position of Secretary, [illegible] and passed into semi-retirement on Dec. 31 last, [illegible] having been retained by the directors in a consultative [illegible]

[illegible] exceeding £35,000,000. Amongst [illegible] company, the [illegible] is the [illegible] London. [illegible] roll of leading [illegible] years of service, [illegible] Mr. [illegible] succeeded by [illegible] James [illegible] Great Central [illegible] Mr. [illegible] Mr. Campbell [illegible] Freeman of [illegible]

The Labour Programme.—[illegible] Labour Party [illegible]

[illegible]

If unemployment should threaten to become widespread it is recommended that the school-leaving age should be raised to 16, that the number of scholarships and bursaries for higher education be increased, and that the hours of labour of all young persons be substantially shortened, and wherever practicable the hours of adult labour should be limited to not more than 48 hours per week without reduction of the standard rates of wages.

Wotan Pencil Economiser.—From Messrs. Siemens Bros. Dynamo Works (Ltd.), 38 and 39, Upper Thames-street, E.C. 4, we have received one of their Wotan pencil economisers. As at present there is a general appeal for economy and the useful article will no doubt remind recipients of the lighting economy that can be effected by using Wotan lamps.

The novelty, which closely resembles a fountain pen in appearance, enables any pencil to be used up to the last half inch. It is provided with a split tapered bush, to accommodate pencils of varying thickness, either round or hexagon, and should prove an article of utility. The Wotan pencil economisers will be obtainable in the ordinary way through the Siemens branch organisations, but should readers communicate with the company direct, it is essential that they enclose their business card.

Tenders Invited and Accepted.

Electric Crane.

MANCHESTER Waterworks Committee require tenders by Feb. 2 for the supply of an electrically driven Radial Arm Crane. Specification, &c., from the Secretary of the Waterworks Dept., Town Hall, Manchester.

Rotary or Motor Converter.

MANCHESTER Electricity Committee require tenders by 10 a.m. Jan. 16 for the supply and erection of a rotary converter or motor converter plant. Specifications from Mr. F. E. Hughes, Town Hall, Manchester.

Electrical and General Stores.

HAMPSTEAD (London) Council require tenders by 4 p.m. Jan. 17 for one year's supply of electrical and engineer's stores, oils, ironmongery, &c. Forms of tender from the Town Hall.

TOXTETH PARK Guardians require tenders by noon Jan. 27 for three months' Electrical and Engineers' Supplies, Ironmongery, Oils, &c. Forms of tender from the Clerk, 15, High Park-street, Liverpool.

Turbo-Alternator with Condensing Plant.

The Electricity Committee of BOLTON Corporation invite tenders for the supply, delivery and erection of a 7,500 kw. Turbo-alternator, with condensing plant. Specification and form of tender from Mr. W. J. H. Wood, borough electrical engineer, Back o' the Bank, Bolton. Tenders to Town Clerk, Town Hall, Bolton, by noon Jan. 15.

DERBY.—The Corporation have accepted the following tenders:—

Babcock & Wilcox, boiler, £4,500; C. A. Parsons & Co., 4,000 kw. turbo-alternator, £24,000 (subject to addition of 1 per cent. on the contract price for each 1s. a week advance in Government scale of wages); F. W. Brackett & Co., water screen, £355; Firth, Blakeley, Sons & Co., second-hand chimney, £230.

HACKNEY (LONDON).—The Borough Council has accepted the tender of C. A. Parsons & Co. (at £32,395) for a 7,500 k.v.a. turbo-alternator and auxiliary plant.

SALFORD.—The Council has accepted the tender of the British Westinghouse Co. for a 360 k.v.a. transformer at £380, and a e.h.t. switch cubicle at £265.

SHEFFIELD City Council has accepted the following tenders for the Electricity and Tramway departments:—

E. Taylor, Ltd., construction of pen-stock and flushing chamber; Wellerman Bros., erection of sub-station, Upwell-street, £450; Reeves Charlesworth, tramway shelter, £298 15s 2d; S. F. Bowser & Co., oil storage and measuring system, together with pumps, piping, &c., £441 12[illegible]

WATFORD.—The following tenders have been accepted by the Urban Council:—

Bruce Electrical Engineering Co., turbo-alternator, £8,980; Stirling Boiler Co., boiler, £1,750.

Appointments Vacant and Filled.

Applications are invited for the position of junior shift engineer at the new temporary station (Nechells) of the Birmingham Electric Supply Department. Commencing salary £150, rising to £200 per annum, plus £23 extra during the war. Applications to the city electrical engineer, Mr. R. A. Chattock, 14, Dale End, Birmingham, by Jan. 19. *See advertisement.*

A constructional engineer is wanted to take charge of the erection of large power station. Applications to Director of Electric Power Supply, Ministry of Munitions, 8, Northumberland-avenue, London, W.C. 2. *See advertisement.*

Applications are invited for the post of head of the electrical engineering department of the Loughborough Technical Institute. Salary, £220 per annum with £30 war bonus. Applications by Jan. 19.

Applications are invited for the post of Head of the Department of electrical engineering and physics of the Victoria Jubilee Technical Institute, Bombay. Salary Rs. 700. Applications by March 31, 1918, to Mr. D. E. Wacha, Honorary Secretary of Board of Trustees, Byculla, Bombay, India.

Mr. A. H. Bullen, of Stoke-on-Trent, has been appointed mains superintendent at Bedford.

Business Items.

Messrs. Whittaker & Co., scientific and technical book publishers, 2, White Hart-street, E.C. 4, has been incorporated with Sir Isaac Pitman & Sons (Ltd.), as from the 1st inst. Mr. A. J. Rayment, the sole surviving partner in Messrs. Whittaker & Co., will continue to supervise the publication of new technical works for Sir Isaac Pitman & Sons.

The title of Oliver Arc Lamp (Ltd.) has been altered to the "Oliver-Pell" Electric & Mfg. Co. (Ltd.), Granville House, Arundel-street, W.C. 2, with works at Cambridge-place, Woolwich, S.E.

Owing to the Government having requisitioned No. 1 Kingsway, the address of Mr. Sydney Morse is now 79, Queen-street, Cheapside, London, E.C. 4. Telegrams: "Esrom, Cannon, London"; telephone, "Central 489."

Hy. Rumney Latham and Fredk. Wilde (trading as H. R. Latham & Co.), electrical and general engineers, 16 and 18, Vauxhall-road, Liverpool, have dissolved partnership. Debts by Mr. Latham, who continues as a general engineer at the above address, and Mr. Wilde will carry on business as the Liverpool Electrical Engineering Co. at 20, Vauxhall-road, Liverpool.

Fred. Wilson Adams and Wm. Ernest Beardsall (trading as Adams, Beardsall & Co.), electrical fittings manufacturers, East Stanley-street, Salford and Cateaton-street, Manchester, have dissolved partnership. Debts by Mr. Adams.

The partnership between Mr. F. M. Carson and Mr. T. Wozencroft Evans, trading as Carson & Evans, 121A, Bunhill-row, London, E.C. 1, has been dissolved. The business will be continued by Mr. Carson, who will trade as F. M. Carson, and receive and pay all accounts.

Plant Wanted.—Messrs. Kryn & Lahy Metal Works (Ltd.), Letchworth, Herts, advertise for a d.-c. electric motor of about 200 H.P., 500 volts.

Calendars, &c. We have received from Messrs. F. Husband (Ltd.) a miniature card calendar, which has on the reverse side a reminder of Mazda lamps.

From Messrs. Pirelli (Ltd.), 144, Queen Victoria-street, London, E.C. 4, we have received a useful calendar with daily tear-off sheets.

The Victoria Electric Plant Co., of Spencer-street, Westminster, S.W. 1, send us an artistic hand-painted water-colour picture after Edwin Lamasure's original, with monthly tear-off calendar slips attached.

Liquidation.

A first and final dividend of [illegible] will be payable on the 18th inst., at Bankruptcy-buildings, London, W.C., to creditors of Wm. John Fenn, consulting engineer, [illegible], Maida Vale, London, N.W.

Municipal Accounts.

Dewsbury.—The Borough Treasurer's accounts, which were issued last week, give the following particulars of the working of the electricity department for the year ended March 31. [illegible]

Newport (Mon.).—[illegible]

[illegible]

The tramways revenue was £50,935 (£45,140), and working expenses were £31,993 (£30,460), leaving gross profit £18,942 (£14,679), or £20,040 (£15,713) with accrued interest. After interest on capital required £5,654 (£5,686), and sinking fund £4,622 (£4,488), and after providing for war allowances, management, &c., the net profit was £8,610 (£4,611). Total revenue per car-mile was 13·43d. (11·76d.), and working expenses were 8·44d. (7·93d.). Passengers carried were 11,456,530 (10,017,515), car-miles run 910,020 (621,133), and units used 1,204,902 (1,159,261) = 1·32 (1·25) per car-mile. Gross capital expenditure is £196,255, of which £59,512 has been repaid [illegible].

Wednesbury.—The accounts of the electricity department for the year ended March 31 show gross capital expenditure £50,015 (increase £1,438), of which £33,554 is outstanding.

Income was £12,387 (compared with £10,860 in previous year), and after paying working expenses and special [illegible] £1,355 (£2,537). Instalment of principal required £2,048 (£1,813), interest £1,389 (£1,258), writing off market lighting and free wiring £349 (£349), and provision for bad debts £30 (£30), and the net deficit for the year was £3,818. Lighting connections are equal to 30,323 (27,965) 8 c.p. lamps, and power and heating [illegible] (58,127) 8 c.p. lamps. Total maximum supply demanded was 960 kw. Units generated were 1,380,690, purchased 1,521,733 and sold 2,084,940.

Companies' Meetings and Reports.

BLACKPOOL, ST. ANNE'S & LYTHAM TRAMWAYS CO. (LTD.)—At the recent meeting it was reported that the past year's [illegible] £44,412 and the expenditure was £33,134, leaving £11,287. Debenture stock interest absorbed £7,500, and £2,000 was placed to sinking fund. The surplus (£1,787) went in reduction of the [illegible] balance, which is now £40,132.

BRITISH COLUMBIA ELECTRIC RAILWAY CO. (LTD.)—At [illegible] held last week the speech of the chairman (Mr. R. M. Horne-Payne) was read by Mr. H. G. Brown. It stated that the results of the working for the year ended June 30 last only enabled them to pay the full dividend on the 5 per cent. cumulative preference stock by taking £44,000 from the reserve fund, but in the preceding year they had to take £70,000 from the fund in order to make the same payment. The gross earnings for the first five months of the current year increased by nearly $200,000 over those for the corresponding period of the preceding year, but the increase in the net income was only $20,000. The increase in gross earnings was due to a very marked improvement in trade and business in British Columbia. If, therefore, as a result of the report of the recent commission of inquiry, jitney competition was abolished and other conditions were fairly adjusted, there was reason to believe that less difficult times were in store for the company. [illegible] public inquiry into the transportation problem [illegible] competition, found that it was not possible for both an efficient tramway service and a jitney service to continue, [illegible] charges for electric light were high, while [illegible] charges for the transportation service were low, and he proposed [illegible] charges and services with the elimination of [illegible] into competition with the company's rights.

BUENOS AIRES PORT & CITY TRAMWAYS (LTD.)—The report for the period from June 18, 1915, to June 30, [illegible] receiver statements of working [illegible] and the result to June 30, 1916, after allowing for [illegible] the receiver, showed a surplus of [illegible], and for the year ended June 30, 1917, a surplus of [illegible] [illegible]

CHADBURN'S (SHIP) TELEGRAPH CO. (LTD.)—[illegible]

MALTA TRAMWAYS (LTD.)—[illegible]

SULPHIDE CORPN. (LTD.)—[illegible]

VENEZUELA TELEPHONE & ELECTRICAL APPLIANCES CO. (LTD.)— [illegible] 30 last the profit was £18,237 (against £18,255) [illegible] 222 brought forward the available balance is £30,544 [illegible] interest, &c., and £2,399 for excess profits [illegible] to pay a dividend of 8 per cent. on the [illegible] £6,000 to reserve for renewals and depreciation, [illegible] £1,057.

New Companies.

AMALGAMATED TANNERIES LTD. (149,278). [illegible] £3,000 [illegible] 2,000 [illegible] per cent. [illegible] £1 each and 20,000 shares of 1s. each, to take over the business carried on [illegible] Syndicate, Ltd. [illegible] First directors are S. L. [illegible] Brown. Reg. office: The Tannery, Huish, near Langport, Somerset.

BRITISH EXPERT ENGINEERS & PRECISION TOOL MANUFACTURERS LTD. (149,[illegible]). [illegible] £4,000 in [illegible] 800 [illegible] shares of £5 each [illegible] Precision tool manufacturers, [illegible] First directors are E. A. Boynton and F. C. Dowsett. Reg. office, 22, Cross-street, Islington, N.

CHAS. E. BECK & CO. (LTD.) (9,975).—Private company, reg. in [illegible] £1 shares, [illegible] merchants and agents in mechanical, electrical and pneumatic machines, &c. First [illegible] R. Macdonald and H. J. Ladgen. Reg. [illegible]

A. LURASCHI (LTD.) (149,277). Private company. Reg. Jan. 1, [illegible] £2,000 [illegible] business of chemical and [illegible] and thermometer maker carried on by A. Luraschi, also to carry on the business of general glass blowers, makers of chemical and scientific instruments, &c. Permanent directors: A. G. Luraschi, F. L. Perken and E. T. Perken (all British). [illegible]

PYNE HUGHNAN & CO. (LTD.) (1,638F.)—Particulars filed Dec. [illegible] 1916, to take over the business of [illegible] on the business of engineers, contractors, ironfounders, electrical engineers, ship, boat, carriage and [illegible] Rs. 340,000 in 3,400 shares of Rs. 100 each. [illegible] Holborn, W.C., where F. N. Short (manager) is [illegible] to accept service.

WATERTIGHT FITTINGS (LTD.) (149,159.)—Private company. Reg. [illegible] manufacturers of and dealers in watertight fittings in connection with the supply of electricity for lighting, heating, power, &c.

ZWICKY PATENTS SYNDICATE (1917) (LTD.) (149,248).—Private [illegible] £1,000 in £1 shares, to adopt an agreement [illegible] in liquidation, to acquire patents, to manufacture and deal in articles capable of being used in connection [illegible]

City Notes.

COMPANIES STRUCK OFF THE REGISTER.—The following companies [illegible] Joint Stock Companies on Dec. 28, 1917: [illegible] Electrical Engineering & Motor Co. (Carlisle), [illegible] Vanadium, Vibration Sign Synd., N. L. Electric Co.

[illegible] struck off the Register of Joint Stock [illegible] Antiseptic Telephone Drum, Electric [illegible] Tyrone Power Co., Universal [illegible]

CROMPTON & CO. (LTD.) [illegible] have been posted for a dividend [illegible] 7 per cent. per annum for the [illegible]

DUBLIN UNITED TRAMWAYS CO. (1896) (LTD.)—A dividend of [illegible] been declared on the ordinary shares [illegible] placed to reserve and renewal fund, [illegible] investment [illegible]

EDISON SWAN ELECTRIC CO. (LTD.)—[illegible] ordinary general [illegible] presiding, the shareholders [illegible] the reduction of the company's [illegible]

LIMA LIGHT, POWER & TRAMWAYS CO.—[illegible] declared [illegible]

MANILA ELECTRIC RAILROAD & LIGHTING CORPN. (LTD.)—The [illegible] a dividend of [illegible] per share for the quarter [illegible]

WATER SOFTENERS (LTD.)—The accounts for the year ended June 30 [illegible] depreciation [illegible] profit of £4,718 [illegible] £1,343.

The Round Table.

By "kVA."

From "The Skyscraper," the humorous journal and record of the anti-aircraft boys, I reproduce the following silhouette, by permission of the editors. I will say more about this breezy journal next week.

FRAGMENTS FROM THE FESTIVAL.
CHARLIE: WHAT ARE YOU LOOKING FOR FREDDIE.?
BERTIE: I'VE HIC - LOST MY GLASSES.
CHAS.: HERE YOU ARE. WE FOUND THEM.
B. W.: GOOD - HIC - FILL 'EM UP AGAIN.

Electro-Harmonic Society.

SEASON 1917-18. FOURTH CONCERT.

To-night, Venetian Chamber, Holborn Restaurant.

Unofficial Programme.

BY "kVA."

In the Chair "BOOSTER" HIGHFIELD.

BIRCH & CRISP CHORUS "Cory, oh More" *Alexander.*
THE STAFFS OF SIEMENS.

ONE WAY SOLO "Save Our Switches" *Tremoblled.*
LEKTRIK MERREN PAYCOCK.

BUREAU CRAZY "Never let your right hand know what your left hand's going to do" *Ages.*
D. O. R. A.

PREFERENCE PATHETIQUE "We feel VERY Hackneyed Now" *Scrattoned.*
THE GAS LIGHT & COKE CO.

HO GLEE "They couldn't take a rise out of Oi" *Cheralier.*
"HACKNEY" ROBINSON.

SECTOR SOLO "I've got the Needle Badly" *Scales.*
ANY LADY "VOLT BOY."

INTER MERZ ZO "We Want Sixteen" ·0005d.
THE SUPER STATION STUNTERS.

PARISH PUMP POWER PLAINT "You in your Small Corner and I in Mine" 1·000d.
THE SUPER STATION SHUNTERS.

DAVY JONES DIRGE "Down among the Dead Men" *Outed.*
THE DIRTY CREW OF ANY DIRTY U-BOAT.

GOD SAVE THE KING.

* * * *

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, January 8, 1881.]

RÉUNION.—Progress is shown in the island, inasmuch as a railway is to be constructed, and the telegraph wire, which was hung up in [illegible] on the branches of trees skirting the high road around the coast, is to be once more stretched out and follow the track of the railway.

MESSRS. SIEMENS.—The partnership heretofore subsisting between Ernst Werner Siemens, Charles William Siemens and Carl Heinrich Siemens, under the firm of Siemens Brothers, of 12, Queen Anne's Gate, Westminster, telegraph engineers, electricians and contractors, has been dissolved by mutual consent, and in future the business of the firm will be carried on by Siemens Brothers & Co. (Ltd.), which company will receive all moneys owing to the firm and will discharge all liabilities thereof.—*Standard.*

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

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CONTENTS.

Notes.

The F.B.I. and Education.

It is, perhaps, a coincidence that in the same week as Mr. Fisher, the Minister of Education, has introduced another Education Bill, a memorandum should have been issued by the Federation of British Industries criticising the provisions of Mr. Fisher's previous Bill, which was withdrawn owing to opposition to various administrative details. It will be remembered that in that Bill whole time education was contemplated up to the age of 16 and part time education in continuation schools up to the age of 18. In the present memorandum exception is taken to this policy, as the committee feel it is impracticable to obtain all that is desired at a single step; consequently the recommendation is made that, in place of compulsory part time continuation education, a liberal system of whole time education should be given amply to those selected children who appear to be the most promising. The committee feel that a period of eight hours a week taken out of working hours would impose a burden which many industries would be unable to bear except as the result of a process of very gradual development, and attention is called to the fact that in many trades a very large proportion of the employees are under the age of 18. We are inclined to think that the difficulty is somewhat overrated, for it is not proposed to interfere with those youths who are already at work. Thus the scheme would only affect children who are leaving school, and consequently the effect of the change would be felt somewhat gradually. At the same time [illegible] and there is certainly a good deal to be said in favour of the thorough training of selected children as a first step, rather than incomplete training for all and sundry. Also we do not feel that the withdrawal of young people from industry [illegible] should be a very serious matter if it is arranged on a proper basis. On the other hand, if it is not arranged systematically we can quite imagine that it would introduce considerable difficulties. There is one point in the memorandum for which we fail to see the necessity, and that is the suggestion that the secondary and junior technical courses would necessarily be voluntary. In other words, the selected children would take advantage of these courses only if their parents thought fit to allow them to do so; and in order to gain the consent of the parents to this extended education it is suggested that certain inducements should be offered to the parents, such as a graduated sum per week, as a recompense for the loss of the earning power of their children. It appears to us that, if a prolonged education is to be for the benefit of the child, and thus indirectly for the benefit of the State, this option should not be given to the parents. If such inducements be given it is obvious that the State will almost invariably be paying for the education and be making payments to the parents at the same time, thus taking a double burden. Special cases would no doubt arise, and should be considered on their merits.

The Question of Teachers.

In regard to teachers, it is felt by the committee, and we think rightly, that any considerable extension of the education programme will necessitate the raising of the quality of teachers, apart from increase in the number. It is pointed out that the mere raising of the present emoluments of teachers, inadequate as they are, will not necessarily bring about the desired effect. It is recommended that teachers should have had not merely a full secondary education, but also university training, except such teachers as are concerned with the instruction of infants. Further, it is felt that there should be greater centralisation of control into larger areas so that the field for promotion of able teachers may be extended. We think it will be agreed that the position of the teacher at the present time is far from satisfactory, and we fear that such steps as have been taken to increase the salaries of teachers have been largely abortive. Lastly, it is suggested that there should be some machinery for connecting up the educational authorities with industry, so that firms desiring young men should have a central bureau to which they could apply. This bureau would be supplied with full information in regard to young men available from the various colleges by which they have been trained. [illegible] desirable, but in all probability it will be supplied before long by the committee appointed in October for the Co-ordination of Engineering Training. [illegible] tional questions involve many interests, and it is therefore well [illegible] the present Education Bill finds a place in the statute book, [illegible]

The Cooling of Motors.

[illegible]

and consequently until new materials are discovered it follows that a point is soon reached beyond which it does not pay to reduce the amount of heat generated. The other direction in which the designer must work is in the dissipation of this heat, which he must accept as an inevitable evil. In this case the more readily the heat can be dissipated the less the material that need be used for a given piece of machinery. In the case of the enclosed motor the conditions for the dissipation of heat are particularly bad, for in many parts of the machine, as generally made, the cooling takes place through considerable masses of metal. Cooling by means of air supplied through ducts has been utilised to some extent, and is effective, but it is a costly method. Designs have been recently introduced in which the air is cooled by taking it to some form of radiator, forming part of a closed air circuit, as it were, with the motor casing itself. This design no doubt offers some relief, but it increases the bulkiness of the plant as a whole. A new method, of which we give a description in another column, is due to Messrs. P. A. H. MOSSAY and H. C. E. JACOBY, and consists in circulating the warmed air within the motor through passages in the casing by means of a fan, the heated air being circulated round and round; the spaces between these passages is cooled by means of air which is passed through them by a second fan, this cooling air being drawn from the surrounding atmosphere. This method, judging from the tests supplied by the makers, appears to be very effective and has the great advantage that it does not materially increase the size of the motor.

Engineering Students in Military Service.

A FEW months ago we quoted some statistics from American journals showing that the participation of the United States in the war was already leading to a marked diminution in the attendance of students at the chief engineering and technical institutions in the United States. We expressed the hope that the United States Government would learn from our experience, and lose no time in allotting such men to work where their special technical training would be useful. In this country, as is now recognised, technical colleges were needlessly denuded of men. Only students of very little military value were allowed to continue their work, and the greater proportion were incorporated into ordinary infantry battalions, where it was merely a matter of chance whether they had any opportunity to use their special knowledge. It is gratifying to notice that the United States Government appears to be taking a wiser course. A communication was recently addressed by the Association of American Universities to the Secretary of War, urging that technical students of a certain standing should, after being drafted, be assigned the military duty of completing their studies in order that their services to the country might be utilised in the most effective way. The War Department has accepted the suggestion. According to a new ruling issued by the Provost Marshall General, the Chief of Engineers is empowered to assign to the reserve corps of the engineering department for the proper completion of their courses a suitable proportion of engineering students in technical schools. The "Electrical World," in referring to the matter, remarks that the effect of the ruling will be to encourage students to secure the best of their training in order [illegible] and we feel sure that this will be generally regarded as a patriotic duty.

British Museum.—The Government has abandoned the proposal of taking over the British Museum for the Air Ministry.

Junior Institution of Engineers.—To-morrow at 7.45 p.m. Mr. F. W. Lanchester will preside at an inaugural meeting of a newly formed section of the Institution at the Dartford Technical Institute.

Shortage of Electrical Appliances in South Africa.—According to the "South African Mining Journal," electrical materials are becoming very scarce in Johannesburg, and the prices of key-sockets and switches have sharply advanced of late. Lamps coming on the market are quickly absorbed, and all kinds of cable material are particularly difficult to obtain. On the other hand, the demand for motors has fallen off somewhat, as the municipality is not in a position to supply new consumers.

Admiralty Reorganisation.—An important memorandum dealing with the recent reorganisation of the Admiralty was issued on Monday.

Among the changes made are the appointment of a civil engineer (Col. Sir A. Gibb, R.E.) to the charge of urgent naval works, and of a director of experiments and research (Mr. C. H. Merz), who will also be a member of the Central Committee of the Board of Inventions and Research (presided over by Lord Fisher). The director of the Signal Division will be Acting Capt. R. L. Nicholson, who has been for some time serving at the Admiralty in the Signal Division. At the outbreak of war he was appointed to the "Iron Duke," the flagship of Sir John Jellicoe, for wireless telegraphy duties, and was the Fleet wireless operator at the Battle of Jutland.

Institution of Electrical Engineers.—At the last meeting of the Institution the President (Mr. C. H. Wordingham) said it had been found practicable to arrange for an informal dinner of the members to be held at the Waterloo Tavern in the Haymarket after each meeting. It was proposed that the Council dinner should be merged in this dinner, and that the President and Council should attend it, as well as any other members who so desired. Some members might feel that it was undesirable to have such a dinner under existing conditions, but the main object was merely to promote intercourse among the members. He invited members who would like such a dinner to be arranged to send in their names to the Secretary before the next meeting.

The Institution of Civil Engineers.—The Council of the Institution of Civil Engineers have resolved that its examination in engineering, drawing, bills of quantities and elementary knowledge of specifications, which is at present an optional subject, shall be after Jan. 1, 1919, obligatory for all candidates for Associate Membership.

The examination is intended to be a suitable test of the knowledge and skill which should be acquired during the requisite training in engineering offices, and will apply to the several main departments of practice. The tests in drawing and quantities may be conducted in part by means of the production of drawings and quantities which have been prepared by candidates under their employers and teachers. Students of the Institution may be allowed to take the examination prior to the time at which they become candidates for election as Associate Members.

Electric Signs and the Conservation of Food.—In the United States the conditions governing the restrictions of outside lighting are essentially different from those prevailing in this country. There is no apprehension of visits of hostile aircraft, and the restrictions now being imposed appear to be dictated solely by the desire to economise fuel. At the same time it is being recognised that illuminated signs are a valuable adjunct to Government publicity, and, with a worthy object, the authorities appear to be willing to sanction considerable expenditure in this direction. It is mentioned, for example, that at the Chicago City Hall two large electric signs, one inside and one outside the building, are being installed at a cost of $5,000 and bearing the motto, "Food will win the War."

A Catalytic Sparking Plug for Motors.—The "Electrical Review and Western Electrician" describes an interesting form of sparking plug for motor-cars that is being developed in the United States, and which utilises "catalytic combustion" to keep the carbon burned off sparking plug insulators, even in the smokiest engine. The method depends on the maintenance of a high temperature by burning part of the gas-air mixture by catalytic flameless combustion throughout the entire period of the compression-stroke, when there is plenty of fresh air in the cylinder. The new sparking plug described is provided with a catalytic structure, in addition to the electrodes and insulators, which produces heat by oxidising the mixture above mentioned. The catalytic

flameless combustion produced by this material is distinct from ordinary flame combustion of the kind that inflames and explodes the whole charge of gas and air, thus producing propulsion. The insulator is kept nearly red hot, and therefore does not receive any deposit of soot, but it does not interfere with the electric spark.

Diesel Engine Users' Association, December Meeting.—At the December meeting of the Diesel Users' Association, Mr. Napier Prentice, engineer and secretary to the Suffolk Electricity Supply Co., was elected president, and Mr. Percy Still re-elected as hon. secretary. The total membership of the Association has now reached 88, representing a total Diesel engine horse-power of 52,451. The Association is represented by members and subscribers in many parts of the overseas Dominions, in the United States, China and South America. A Paper by Mr. E. A. Evans on "Lubrication" was read, and two supplementary contributions by Mr. G. W. F. Horner and Mr. J. V. Wilson dealt with certain lubrication difficulties in Diesel engines and their air compressors. Other Papers dealt with "The Working of Diesel Engine Installations," "Automatic Control of Blast Pressure for Diesel Engines," and "Compressed Air Supply." Attention is still being given to the important subject of tar oil as fuel. A set of rules for the Association has been formulated and circulated amongst the members and subscribers.

Motor-Driven Tools.—An article by Mr. C. E. Clewell in a recent issue of the "Electrical World," reviews the application of motors to machine tools, such as rotary drills, planers and lathes, and summarises in a concise form the advantages of this method of driving. Separate motor-driving has been steadily developing during recent years; the flexibility of the method is a great advantage and is now held to outweigh the greater first cost. The advantages become specially evident when it is desired completely to revise the grouping of the machines in a shop, or to convert it to new processes. Only with light machines worked steadily in groups at a fairly uniform output can group-driving be considered advantageous. At the present moment the rapid alterations of plan to which many works are subject, and the need for rapid new installations to cope with overtime and extra work make the individual drive particularly advantageous. Yet another merit claimed by Mr. Clewell for this system is that it greatly simplifies the lighting problem. A room which is cluttered up with a great deal of belting or shafting can only be properly lighted with extreme difficulty.

Oxacetylene Welded Joints in Steel Plates.—A series of tests of the strength of oxy-acetylene welded joints in mild steel plates [illegible] Engineering Experiment Station of the University of Illinois. [illegible] conditions of loading: (a) static load in tension (in a testing [illegible] tests, the joint efficiency sometimes reaches 100 per cent. [illegible] have been published as Bulletin No. [illegible] of the Engineering Experiment Station [illegible] by addressing Mr. C. R. Richards, Director, Urbana, Illinois.

Obituary.

DEATH ON ACTIVE SERVICE.—The following is reported to have died on active service:—

Second-Lieut. A. W. H. [illegible] (R.G.A.), aged 24, died as a prisoner of war in Belgium on Nov. 20 of wounds. He was formerly engaged in the works of Messrs. [illegible] his father is a director. Deceased had served [illegible] three years, and obtained his commission in [illegible]

Personal.

Mr. James N. Wilson, secretary and [illegible] of the [illegible] Corporation tramways department, has been appointed [illegible] of the Board of Trade Tramways Control Committee.

Vice-Admiral Sir R. H. S. [illegible], K.C.B., has been appointed Controller of the Munitions Inventions Department, in succession to Col. H. E. F. Goold Adams.

Mr. H. Barge, engineer at Messrs. Bullivants, Millwall, E., and son of the chairman of the Poplar Electricity Committee, has been appointed Officer of the British Empire, and figured in the recent honours list.

Another new member of the Order of the British Empire is Mr. James Connor, works manager for Messrs. Dick, Kerr & Co., of Preston, and head of a department which has been extensively engaged on munitions.

Mr. E. J. Jennings, secretary and accountant to St. Marylebone electric supply undertaking for the past 15½ years, whose resignation has now been accepted, is taking up his new appointment as secretary to the Birmingham electric supply undertaking, in succession to Mr. Howard Foulds, on the 1st prox.

Arrangements for the Week.

FRIDAY, Jan. 18th (to-day).

ROYAL INSTITUTION.

5 p.m. At 21, Albemarle-street, London, W. 1. Discourse on "Studies on Liquid Films," by Prof. Sir James Dewar, F.R.S.

JUNIOR INSTITUTION OF ENGINEERS.

8 p.m. At 39, Victoria-street, London, S.W. 1. Paper on "Power Plants, Maintenance and Advantages of Steady Running," by Mr. R. Rankin.

SATURDAY, Jan. 19th.

ROYAL INSTITUTION.

3 p.m. At 21, Albemarle-street, London, W. 1. Lecture on "The [illegible]" by Prof. W. [illegible], F.R.S. (Lecture I.).

MONDAY, Jan. 21st.

ROYAL SOCIETY OF ARTS.

4.30 p.m. At John-street, Adelphi, London, W.C. 2. [illegible] by Mr. C. R. Darling (Lecture I.).

TUESDAY, Jan. 22nd.

[illegible]

WEDNESDAY, Jan. 23rd.

ROYAL SOCIETY OF ARTS.

[illegible]

THURSDAY, Jan. 24th.

[illegible]

FRIDAY, Jan. 25th.

[illegible] London, S.W.

[illegible]

A Modern Granary.

THE EQUIPMENT OF THE CLYDE TRUSTEES' NEW GRANARY AT MEADOWSIDE.*

Summary.—This granary has a storage capacity of 31,000 tons of wheat. It is provided with an extensive equipment of conveyors and elevators, so that the wheat can be unloaded from boats and be delivered to any one of the 12 floors; and, conversely, so that loading of all kinds can be effected with a minimum of labour.

It was our intention to give in our recent issue of THE ELECTRICIAN dealing with the Handling of Materials a description of a modern granary, but restrictions on our space rendered this impossible. We think, nevertheless, that an account of the very complete equipment of the Meadowside Granary will be of interest in itself, apart from kindred subjects, and therefore in what follows we give some details taken from Mr. G. E. Baxter's Paper on this subject, which was read before the Institution of Engineers and Shipbuilders in Scotland. The granary was erected by the Clyde Trustees.

GENERAL DESCRIPTION.

1. *Buildings.*—The building is 312 ft. long by 72 ft. wide inside, and has a storage capacity of 31,000 tons of wheat. It is divided into two portions, one of which, 168 ft. in length, contains silo bins, while the other, 144 ft. in length is devoted to floor storage. Three lines of rails run through the building, and are flanked by loading-out platforms which form the ground floors. These lines are connected with others outside the granary by a traverser at the west end of the building. Verandah roofs are provided outside on the north and south sides of the building, under cover of which 24 carts or lorries can be loaded simultaneously.

In the silo bins an aggregate of 20,000 tons of grain can be stored. The storage capacity of these bins ranges from 28 up to 275 tons. Some of the bins are provided with anti-grading cones, and some with Pottinger's patent distributers, which are referred to later, and the object of which is to provide against grading of the grain while being drawn from the bins.

In the floor storage portion of the building provision is made for storing 11,000 tons of grain in bulk or in sacks on 11 floors, with a depth of 5 ft. 6 in. of bulk grain on each floor. The main elevator tower in the centre of the building is 36 ft. by 24 ft., and rises to a height of 160 ft. from ground level. The building and subways are electrically lighted, and the whole of the machinery inside and outside of the granary is operated by electricity.

2. *Machinery.*—On a length of 900 ft. of the quay, rails are laid for the two travelling ship-discharging elevators, each of which is capable of discharging 250 tons of wheat per hour from a steamer alongside the quay. Each ship elevator is provided with two 1,000 lb. automatic grain scales for weighing the grain as it passes to the longitudinal conveyor bands in the subway at the back of the quay wall.

These bands deliver the grain to transverse conveyor bands situated in the cross-subways leading from the quay subway to the two main elevators in the granary. These, working at the same rate as the ship elevators, raise the grain to the conveyor gallery at the top of the building, and deliver it [illegible] conveyor bands for distribution [illegible] of the 150 separate bins or to any part of the 11 storage floors.

An auxiliary elevator with a capacity of 100 tons per hour [illegible]

[illegible]

Two [illegible] sack [illegible], each capable of dealing with 500 sacks per hour, are provided at the east and west ends of the floor granary. By these bands sacks may be conveyed from the floor of the shed to the sixth floor or the

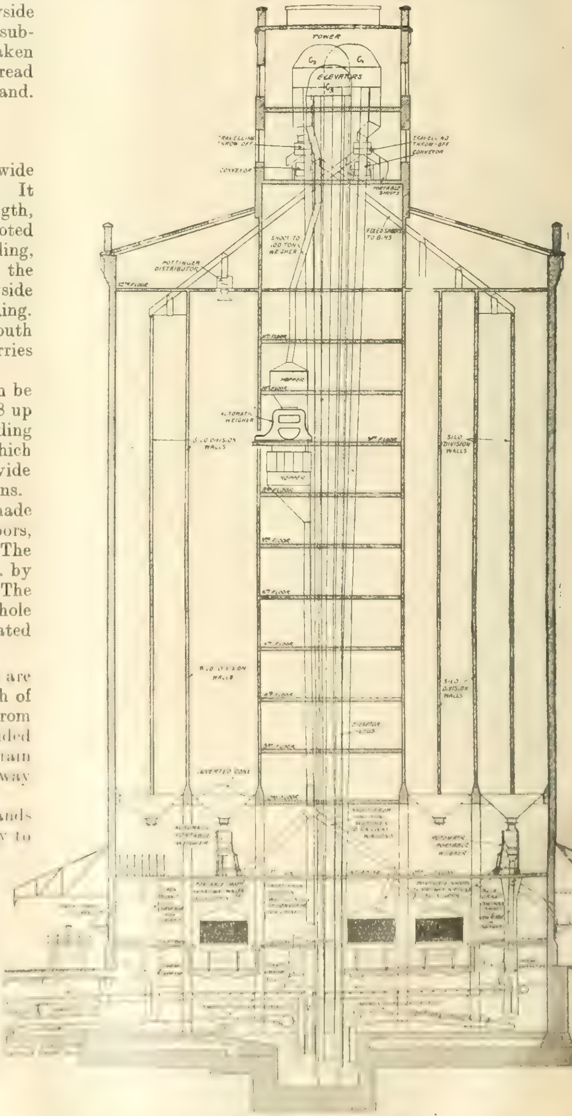


FIG. 1.—INTAKE PLANT BULK GRAIN.

[illegible] floor of the granary, distributed by horizontal bands on these floors and passed through any of the nine "Swiftsure" sack shoots to any of the lower floors.

Bulk grain can be taken direct from any bin or floor, weighed, and delivered through shoots into carts outside the granary, into wagons on any of the three lines of rails inside the granary, or on to the bands in the basement, and from them conveyed by the loading-out band in the cross subway to a lighter alongside the quay at the rate of 100 tons per hour. Bulk grain can also be weighed direct into sacks immediately under the portable automatic net weighing machines on the sacking-off floor, and distributed in any of the three methods described. Sacked grain from any floor can also be distributed in the same directions at the rate of 500 sacks per hour.

The section of the granary (Fig. 1) shows the two main elevators which lift the grain to the conveyor gallery and deliver it on to the bands D1 to 4, whence by means of throw-offs the grain is led to any of the bins or to any part of any floor.

In the shed are two inclined intake sack conveyor bands which, rising from the floor, pass through the roof of the shed and the gantries between the shed and the granary. The intake sack-bands deliver on to a central band running from west to east on the sixth floor. A hinged part of this central band leads on to an extension of the east intake sack band, which, continuing to ascend alongside the east end and north side of the floor granary, crosses to feed the central band on the 12th floor.

In the basement below the loading-out platforms, Fig. 1, are shown in section three conveyor bands (F1, 2, 3) in the silo-portion. These with three similar bands (F4, 5, 6) in the floor portion, all lead inwards towards the loading-out band G, shown in the transverse subway, leading on to the inclined loading-out band G1 connected to a shoot band, G2, in the loading-out structure, whence the grain is delivered into a shoot leading to the hatch of the vessel.

EQUIPMENT.

3. *Intake Plant for Bulk Grain.*—This includes two travelling [illegible]

[illegible]

structure. Current is taken by flexible cable from a line of 21 plug-connection boxes spaced along the quay, about 50 ft. apart.

4. *Quay Shoots and Conveyor-Bands in Subways.*—There are 54 cast-iron quay shoots spaced 20 ft. along the quay. Each shoot is provided with a water-tight cover and two square branches with a valve, worked from below, to direct the grain to either of the two lines of conveyor-bands in the quay subway. As the quay is on a curve, these bands are arranged in a series of tangential straights.

5. *Interlocking Arrangements.*—In order to avoid chokes of grain in the quay and cross subways, the motors driving the two lines of intake conveyor-bands are each fitted with solenoid automatic starters controlled by master switches, placed in boxes fixed to the columns of the shed on the quay, and are so interlocked electrically with one another that if one band is started all the bands between it and the main elevator in the granary, but none of the bands between it and the ship elevator, will be started. While grain is being taken in, and should any of the bands stop through an overload of the motor, failure of current, or other cause, the bands between it and the ship elevator will be automatically brought to rest, but the bands leading to the main elevator in the granary will continue to run, and thus avoid a choke.

6. *Two Main Elevators in Granary.*—These are marked C1 and C2 in Fig. 1. Each is 165½ ft. long between the centres of the terminals, and can raise 250 tons of wheat per hour through a height of 171 ft., delivering the grain on to conveyor-bands D1, 2, 3, or 4 in the gallery. On each of these elevators are 343 buckets of 0·65 cubic ft. capacity, and at 12 in. pitch.

7. *The Auxiliary Elevator* C3, which is arranged close to the main elevator C2, is 163 ft. long between the centres of the terminals, and can raise 100 tons of wheat per hour through a height of 167 ft., delivering the grain to a 3,000 lb. automatic weigher when loading out bulk grain to carts, to wagons on the rails inside the granary, to lighters alongside the quay, or, if required, when turning over.

8. *Conveyor-Bands in Gallery.*—In the western half of the gallery at the top of the building are two conveyor-bands over the silos. In the eastern half two conveyor-bands the same way distribute grain to any part of any floor through a number of [illegible]

The two sections of the intake plant for bulk grain described above [illegible]

9. *Bulk Grain Shoots* [illegible] part of the granary there are 28 fixed bulk grain shoots leading [illegible] able shoots to carry grain from either of the conveyor-bands in the gallery [illegible]

(To be continued.)

Books Received.

[illegible]

Gas-Fired Boilers.

The following is an account of a discussion which took place at the Manchester Local Section of the Institution of Electrical Engineers on Mr. T. M. Hunter's Paper on the above subject. An abstract of the Paper appeared in THE ELECTRICIAN of Nov. 23 and 30.

Mr. DRUMMOND PATON referred to the carbonisation of coal and the [illegible] of pyrometric control.

Mr. T. R. WOLLASTON remarked that the author appeared to have [illegible] Lancashire and water tube boilers, [illegible]. There was only casual reference to the only essentially gas-fired boiler, the "Bonecourt." Two or three references in the Paper implied that gas-fired [illegible]. The "Bonecourt" worked at over 90 per cent., and he was satisfied that when the problem was properly tackled by skilled boiler makers at least 85 per cent. would be reached. This, with a producer efficiency of 70 per cent. (which would also be consistently obtained), it would give substantially 60 per cent. all round efficiency, equal to what some electrical stations were now working at without by-products. The speaker had carried out a series of tests on gas-fired Lancashire boilers with producer gas and with Bunsen type [illegible] Mr. Hunter had [illegible] improved, and he was perfectly sure of the gas analysis. The test lasted for nearly a week and an average of 17 per cent. CO_2 in the gas, never any CO, and never more [illegible].

Dr. CRAMP said that gas could be used for boiler purposes either in a producer which was entirely apart from the boiler, or in a producer which was part of the boiler. For small plants a producer attached to or forming part of the boiler was a method which should not be lost sight of. It was perfectly true in that way one did not get the advantage of by-products, but such producers had been successfully built, and it had been shown that by their means greater economy in the consumption of coal per lb. of steam was obtained. The author pointed out the loss due to moisture in the flue gases and that if an economiser would stand the condensation of the water on its sides, the temperature of the gases could be reduced and very much more heat got out of the flue gases. Why had that proposition never been properly tackled? There were plenty of metals in use in chemical works which would withstand corrosion. There was a form of radiant energy which was not touched upon in the Paper, viz., radiant flames. Why was it impossible to use a flame not of the Bunsen type, but of the radiant type arranged in the ordinary boiler tube and thus get the radiancy needed without the use of radiating fireclay? He had taken out a few figures and saw no difficulty about it, provided that the quantity of gas given in the Paper was about right for the size of the Lancashire boiler. If such a thing was possible it would be well to know why it was not used. The question of the use of high velocity flue gas was not really one of boiler efficiency at all; it was one of evaporation per square foot of surface and the question whether it was best to use it or not was very largely one of capital cost. If gas passed at very great speed along the surface to be heated a very much greater evaporation was obtained from that surface, but the cost of doing that in pence per hour was probably greater than the interest on capital involved in increasing the service of the boilers to get the same result. An important point in boiler working was that atmospheric pressure, in the case of forced draught, should be as near [illegible]. With regard to the Le Chatelier formula quoted in the Paper, there was some doubt whether it had ever [illegible] and he asked Mr. Hunter whether it really was reliable. The author said the Pitot tube was difficult to work with and get accurate results, and mentioned in the same breath the anemometer, an instrument which had not to be mentioned in the same category [illegible] matter to design [illegible] results. Apart altogether from that, Mr. Hunter did not seem to be aware of the very [illegible] of gas by the [illegible] in his Paper on the Rand Mine[illegible] Paper he would [illegible] in South Africa [illegible] might be adopted [illegible] with a Venturi [illegible] form of [illegible]. One [illegible] before.

[illegible]

out in the estimation of the calorific value. There were one or two mistakes which made a slight alteration in the calculated temperatures, reducing the drop in temperature due to moisture to 230°C. against 284°C., as quoted by the author. There was a big mistake with regard to the loss in efficiency due to the presence of water-vapour. The author's figure of 204 calories lost to the flues with the dry gas was incorrect and should be 141 cals.; also the figure of 297 cals. should be 195 cals. If the calculations were correct throughout, these figures became 140 cals. and 179 cals. respectively. This meant that the loss to the flues was 14·5 and 18 per cent. respectively for the dry and moist gases against the author's figures of 21 and 29·8 per cent. With this correction there was only a difference of 4·5 per cent. in the output from a given quantity of gas and not 12 per cent. as stated. Finally, the results arrived at were considerably altered, the drop in efficiency being nearer 5 than 9 per cent. as stated, and the drop in evaporation only 13 and not 21 per cent. The author had described a Lancashire boiler in which the flue was led into a tube plate as being better suited for gas firing than the straight flued Lancashire boiler. That appeared to the writer very like the ordinary Scotch marine boiler. Was the author aware of any boilers of this type being gas-fired? Marine boilers were now being favoured for land service and it would be interesting to know if they would be of greater service than the ordinary Lancashire boiler for gas firing.

Mr. S. L. PEARCE said the Paper had a twofold aspect. From the national point of view there could be little doubt that to burn raw coal was quite unsatisfactory, but from the central station engineers' point of view it was by no means demonstrated up to the present time that by the adoption of gas firing the engineer would be able to produce a unit of energy at a lower cost than at present. The problem might be helped to a solution by the experimental stations which would be established shortly at East Greenwich. He had not been able to take advantage of by-product gas, whether from coke ovens or from blast furnaces. Therefore, there were two alternatives, either to put down producer plant in its entirety or else purchase gas. It was noticeable that the author himself did not appear to be over-sanguine in regard to the former because he thinks that in no case yet had the gas firing of boilers with by-product producer gas been made a commercial success, as it has been found that steam could be raised more cheaply from the coal direct, even after allowing for all the income from the sale of by-products. With regard to the possible utilisation of town gas, he had made some calculations from the figures which were supplied by the author. As a basis he assumed that no electrical authority, purchasing town gas of which the calorific value was about 500, could afford to pay more than about 2½d. per 1,000 cubic ft. Did the author think it at all likely that gas authorities would be in a position to offer gas at that price to the electrical authority? If they could not he saw very little chance of that co-operation which had been advocated in certain quarters. With regard to producers, he did not want to say much because he hoped that before very long and in a place not many miles from there, it might be possible to install experimental plant working in conjunction with modern marine boilers. As to the suitability of gas for boiler firing, he was not at all impressed by the figures the author gave, in which he talked of it being possible, with suitable combustion arrangements, to obtain evaporations of 5½ lb. per square foot. At one of their stations they were putting down boilers of a marine type, from which they fully anticipated getting 7½ lb. per square foot. On reading the Paper one felt some qualms as to the accuracy of taking the gas measurement, but he was glad to say they had been very much allayed by the remarks of Dr. Cramp.

Mr. S. J. WATSON said the author dealt with the use of gas for firing boilers, which at once raised the question whether that was the most efficient method to use gas. The success of gas firing in boilers was very largely one of securing a steady flow of gas. Mr. Hunter referred to the considerable use of Lancashire boilers in connection with gas burning. The Lancashire boiler was incomplete without an economiser. If, therefore, a fuel was used which contained such a high percentage of moisture as indicated, what type of economiser would be installed? The efficiency of a Lancashire boiler would be very low without an economiser, and with considerable moisture in the flue gases the rate of deterioration of the usual type of economiser tubes must be exceedingly high. On the whole he was inclined to agree with Mr. Pearce that there was little likelihood that gas-producing plants for the firing of boilers were going to be [illegible] generally for the present method of coal firing. When [illegible] product instead of one of the principal products the position was [illegible]. With regard to the transmission of gas over appreciable distances, it seemed to him that the distribution of gas over large [illegible] without suffering the effect of a somewhat [illegible] would be very useful if Mr. Hunter would give a few [illegible] the loss which might occur under such conditions. Mr. H[illegible] mentioned that the cost of producing one ton of steam was [illegible] from coke oven gas. Coke ovens were invariably estab[illegible] collieries, and the cost of 1s. 3d. approximately corre[illegible] 10 a ton. He did not assume that the class of coal [illegible] colliery would have a value [illegible], it would probably be more like [illegible] or, perhaps, [illegible] that the comparison in this particular instance [illegible] one.

Mr. [illegible] said the author mentioned water tube boilers [illegible] he had been connected with the manu-

facture of both types for many years he might be assumed to know something of their limitations. The very virtues of the Lancashire boiler had been its undoing. It can work with any sort of water, it never required any attention or repairs. The water-tube boiler might be looked on as the delicate child of the family. Both types, however, had been brought up on very different fare to that now offered by Mr. Hunter. Clean water and clean gas were very different conditions to what the Lancashire boiler had and what even the water-tube boiler could get to-day. The water-tube boiler had emphasised the necessity for clean water, and the large gas engine the necessity for clean gas, and given clean water and clean fuel the possibilities were almost beyond our dreams in the way of improvement in boiler design. One such improvement would be the adoption of the Lancashire multitubular boiler. He showed a diagram of a boiler, four of which were made 30 years ago. The feature of the design was, as described by the author, an enclosed combustion space which avoided losses by air leakage or radiation, combined with a reasonable amount of [illegible] The author referred to sufficient combustion space being an essential point in a water-tube boiler. It seemed to him that this entailed considerable wear and tear of brickwork and loss through radiation, although the figures given in the Paper did not substantiate that. Very much lower figures for radiation losses were given from the water-tube boiler than from the internally fired boiler, which was not what would be expected. Another point was whether that covering of the brickwork with tar had been found to be satisfactory [illegible] to be a valuable hint to all users of boilers. The author also mentioned several methods of increasing the output of the boiler, but he ventured to suggest that most of them were illusory compared with the fourth method, especially if clean fuel and water were available. After describing it the author referred to Dr. Nicolson's experiments. He gathered in conversation that he was not in possession of the complete data of Dr. Nicolson's experiment, and all the figures given were not correct. He would be glad to pass the complete information on to him.

Mr. W[illegible] had not given some examples of the practical application of gas-firing. As the space required for the producers for very large boilers going up to 100,000 lb. evaporative capacity per hour was greatly in excess of that required for the boilers themselves, it would alter the plans of the lay-out of the station, and necessitate the covering of much more land.

Mr. BERRY said the "Bonecourt" boiler was designed and first brought into use in this neighbourhood and the results were so astonishing that a very large experiment of boiler was put in at the Skinningrove Iron Works. It was fired with [illegible] The efficiency, on several tests, was maintained at 92 [illegible] per cent. was deducted for the fan, so that the efficiency was [illegible] No other boiler yet designed came near that in heat efficiency. It was so satisfactory that the Skinningrove Co. ordered a second boiler. A marine boiler put in at the Birmingham Battery Co., evaporated 11,000 lb. an hour, and the efficiency was just about the same. At the present time boilers were being designed for [illegible] pressure. The only thing [illegible] conservatism of engineers who did not like [illegible] had done the experimental work [illegible] his experience. The "Bonecourt" boiler was the most scientifically designed boiler known. The [illegible] and it was possible to get down the temperature of the gases discharged at the end of the boiler to just a few degrees above [illegible]

Mr. HUNTER, in reply, [illegible] in the Paper because it was [illegible] fired boilers that are absolutely reliable. Large boilers fired with coke-oven gas without [illegible] per cent. They were further tested by an outside engineer some two years or so after they had been set up [illegible] working was 82 per cent. [illegible]

[illegible]

Reopening of the Science Museum, South Kensington.

[illegible]

Electric Cooking as Applied to Large Kitchens.

A discussion took place on the 8th inst. at Edinburgh on Mr. W. A. Gillott's Paper entitled "Electric Cooking as Applied to Large Kitchens" (which we gave in abstract in our issue of December 7th, p. 336).

The CHAIRMAN (Mr. A. Page) said that after hearing Mr. Gillott's figures with regard to the possibilities of electric cooking, the supply engineer would appreciate the large outlet for business which was to be looked for from this quarter.

Mr. C. G. NOBBS (Falkirk Iron Co.) said that electrical maintenance might be taken as about one-quarter that of large coal and steam installations. The running load was only 25 per cent. of the full-load rating. The full-load might be on for 15 to 45 minutes to bring ovens to working temperatures. There was, however, a large diversity factor which tended to increase the load factor. The curves of diversity might be flattened out by arrangement, cooking being practically completed between 7.30 a.m. and 10.30 a.m. A combined electrical and steam plant could easily be arranged to give a load-factor of 50 to 70 per cent. In an oven he had designed for baking 500 loaves per hour the consumption was one-tenth to one-twelfth of a unit per loaf. While he would not advocate the premature standardisation of elements at the present stage of development, he thought that contractors and others should carry stocks of spare elements. Purely electrical men seldom made efficient salesmen, and he preferred to train men having experience with gas or steam.

Mr. H[illegible] in Glasgow they were about to convert a kitchen in one of the principal Glasgow restaurants. He asked the author to state the rate charged for current to restaurant "A" mentioned in the Paper. The electricity department of the Glasgow Corporation had equipped the first electric canteen in Scotland fully a year ago. It had a capacity of 56 kw., and was for 250 workers. It had been an unqualified success. At the moment they were completing three all-electric installations, one for 100 people (45 kw.), one for 250 people (70 kw.), and one for 500 people (137 kw.). They had an 80 kw. electric cooking equipment at a large hospital, accommodating 300 wounded soldiers, with staff in addition. The daily consumption was 130 units, or 0·37 of a unit per person per day. In a Government factory they had an equipment in four kitchens aggregating 350 kw. As a municipal concern, therefore, they had not been asleep. The business of electric cooking and industrial heating had just begun to be tapped, and the revenue to be derived from it, if it were properly handled was only second to the revenue to be got from power supplies. They had just converted a coke-fired baker's oven by means of six 3 kw. heaters fitted to the roof of the oven, and there were five other ovens awaiting conversion, the total maximum demand being 108 kw. The other uses of electricity in this factory only ran to 10 kw. He agreed with self-contained apparatus for boiling, and he urged manufacturers to tackle the problem of the hotplate for boiling. With that single exception, whatever gas could do, electricity could do better, and the Paper would serve to show the importance of electric cooking to architects, consulting engineers and electrical engineers, [illegible] much as any.

Mr. SMITH (Greenock Corporation) said the electric grill and the baking plate were the apparatus he found most acceptable. He suggested that experiment should be made with radiant heat as a substitute for the hotplate. In his opinion the oven with top and bottom heat was to be preferred to the oven with side elements. He thought the author had not sufficiently emphasised the saving obtained from electric cooking [illegible]

Mr. HENDERSON (Edinburgh) said that electric heating for biscuit baking was very convenient, but the apparatus required further im[illegible] first part of the operation they wanted steam, but they required a dry [illegible]

Mr. [illegible] improve the load factor on the plant.

[illegible]

Turbo-Rotor Cap-Rings.

By R. ROBERTS.

[illegible] investigates the [illegible] of stress in turbo rotor cap-rings, and, by means of examples, shows how these stresses [illegible] calculated for some commonly used designs. In conclusion, he summarises the points that may be considered when designing these cap-rings.

Within recent years the construction of A.C. turbo generator rotors has become fairly standardised for machines of moderate output, *i.e.*, up to about 3,000 kw. Above this output the rotor designs vary greatly in detail. In the standardised design the rotor winding, consisting of concentrically wound coils, one group per pole, are embedded in slots distributed round the rotor periphery. The ends of the concentrically wound groups of coils overhang the ends of the rotor core, and need to be supported against the centrifugal forces occasioned by the high speed of revolution. The usual method of doing this is by means of cap-rings of either steel or manganese bronze, which are supported against the rotor core at one of their ends and by some support at the outer end.

An inherent disadvantage of the concentric groups of coils is that the weight of the end windings cannot be evenly distributed around the periphery of the cap-ring. Some manufacturers add loose weights to equalise the distribution of load upon the cap-ring. In some designs this is necessary unless very heavy rings are used so as to keep the stresses produced by the bending moments occasioned by the dissymmetry of loading within reasonable limits. In general, however, the use of added weights is to be deprecated, and a rotor constructed without added weights requires less supervision [illegible]

[illegible] different designs of cap-rings can be made is the formation of shape of the end winding groups. The more common design of coils is such that [illegible] the same for all the [illegible] preferable from a manufacturing [illegible] jigs and tools [illegible] rating than would another method, in which the inside coil is wound round as small a radius as is practicable, whilst the radii at the corners of succeeding coils are made as large as is permissible. Each design has its good points; and which design should be preferred can only be settled by shop conditions apart from design of the cap-ring. Fig. 1 shows a typical rotor in half section, whilst Fig. 2 shows the developed plan of one pole group of an end winding when the corners of the coils have the same radii. Fig. 3 shows a similar plan for coils having increasing radii at the corners. In the following investigation I will deal throughout with two cases. Case I. will deal with an end-cap supporting a winding as shown in Fig. 2, and Case II. with that of a winding shown in Fig. 3.

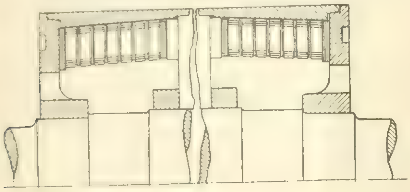


Fig. 1

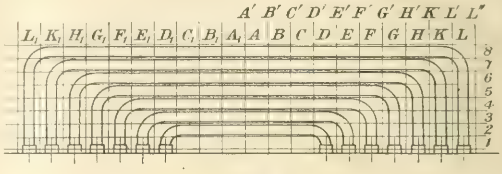


Fig. 2.

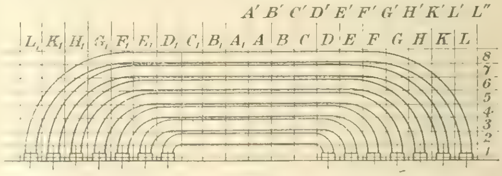


Fig. 3.

The stresses will be considered separately under the following headings:

A. Self hoop stress.
B. Load hoop stress.
C. Support shear stress.
D. End-ring stress.
E. Constructional stress.
F. Summation of stresses.
G. Link stress.

A. Self hoop stress is that stress induced in the cap-ring by its own weight, and is entirely independent of the load

Table I

[illegible]	A	B	C	D	E	F	G	H	K	L	1, 2, &c.
[illegible]	[illegible]	[illegible]	[illegible]	1,400	1,400	1,400	1,400	1,400	1,400	560	13,160
[illegible]	[illegible]	1,410	[illegible]	1,410	1,410	1,410	1,410	1,420	560	990	12,840
[illegible]	[illegible]	[illegible]	[illegible]	1,430	[illegible]	1,430	1,430	560	990	870	12,430
[illegible]	[illegible]	[illegible]	1,450	1,450	1,450	1,450	570	1,000	870	870	12,040
[illegible]	[illegible]	[illegible]	[illegible]	1,460	1,460	[illegible]	1,000	880	880	880	11,510
[illegible]	[illegible]	[illegible]	1,480	1,480	[illegible]	1,010	880	880	880	880	[illegible]
[illegible]	[illegible]	[illegible]	1,500	800	[illegible]	880	880	880	880	880	10,710
[illegible]	[illegible]	[illegible]	[illegible]	900	880	880	880	880	880	880	6,180
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8,450	7,900	[illegible]	6,810	89,860

Table II

[illegible]	A	B	C	D	E	F	G	H	K	L	1, 2, &c.
[illegible]	[illegible]	[illegible]	[illegible]	1,400	1,400	[illegible]	1,480	0	0	0	9,880
[illegible]	[illegible]	1,400	[illegible]	1,410	1,410	[illegible]	680	[illegible]	0	0	10,850
[illegible]	1,430	[illegible]	[illegible]	1,430	1,430	[illegible]	980	[illegible]	1,270	0	11,440
[illegible]	[illegible]	[illegible]	[illegible]	1,450	1,490	[illegible]	1,300	1,180	1,060	0	11,440
[illegible]	[illegible]	[illegible]	[illegible]	1,470	1,050	[illegible]	800	630	710	980	11,440
[illegible]	[illegible]	[illegible]	[illegible]	1,580	760	[illegible]	960	990	960	930	11,340
[illegible]	[illegible]	1,500	[illegible]	720	1,090	[illegible]	940	920	900	890	10,930
[illegible]	[illegible]	[illegible]	[illegible]	900	880	880	880	880	880	880	6,180
[illegible]	[illegible]	10,130	[illegible]	[illegible]	9,510	[illegible]	8,020	[illegible]	5,780	3,680	83,500

carried by the cap-rings. The ring section is conveniently made uniform around the periphery and the "self hoop stress" may be found by using the well-known formula,

$$Ssh = 12\,C\,V^2/g,$$

where Ssh = Self hoop stress in lbs. per sq. in.

C = Weight of material of ring in lbs. per cubic in.

V = Peripheral speed in ft. per sec.

g = Acceleration due to gravity in ft. per sec. per sec.

For mild steel this becomes

$$Ssh = 0{\cdot}106\,V^2$$

and for manganese bronze

$$Ssh = 0{\cdot}115\,V^2.$$

The example to be considered, not necessarily a good design, but merely an example, has the following dimensions: Rotor diam. 23 inches, wound 2 pole, and the windings are embedded in 28 slots, spaced 40 to the circle, whilst full speed is 3,000 r.p.m. There are two groups of coils containing seven coils per group, as shown in Figs. 2 and 3. The cap-rings are of manganese bronze and the self hoop stress is the same for both Case I. and Case II., viz. :—

$$Ssh = 0{\cdot}115 \times 301^2 = 10{,}400 \text{ lbs. per inch}^2.$$

B. The load hoop stress cannot be calculated so simply, though approximate values may easily be obtained by assuming the load to be evenly distributed and adding a percentage to allow for the dissymmetry of load. For investigation purposes, however, we must find the stress at each point on the circumference. Table I. gives the loading in lbs. distributed over one quadrant for Case I., and Table II. gives similar values for Case II. The positions of the loads are given by figures and letters to correspond with those in Figs. 2 and 3.

If we compare the sums of all the forces in one quadrant for the two cases we find that this sum in Case II. is only 95 per cent. that in Case I. [illegible] speaking a machine wound as in Case II. would [illegible] per cent. [illegible] a similar [illegible] the cap-ring were the limiting factor.

For convenience in obtaining certain stresses we will lump the various loads about the ends or supports of the cap-rings. This can be done by treating each segment, A, B, C, &c., as a simply supported beam carrying the several loads in Tables I. and II., and finding the reactions at the supports. For example, the unit load $D4$ in Case I. is applied at a point $3\frac{5}{8}$-in. from the outer support, whilst the distance between supports is 8 in. The reaction from this particular load upon the outer support is

$$\frac{4\frac{3}{8}}{8} \times 1{,}460 = 800 \text{ lbs.},$$

whilst the reaction of this particular load upon the core end support is 660 lbs.

Table III. gives the sums of the reactions for each segment of the quadrant in Case I., whilst Case II. is treated similarly in Table IV.

Table III.

Positions.	A	B	C	D	E	F	G	H	K	L
Core end	4,180	4,180	4,180	4,730	4,270	3,970	3,750	[illegible]	3,470	3,440
Outer end	5,650	5,650	5,650	5,600	5,340	5,060	4,700	4,320	3,870	3,370

Table IV.

Positions.	A	B	C	D	E	F	G	H	K	L
Core end	4,490	4,490	4,490	4,760	4,250	3,930	3,760	3,590	3,370	2,600
Outer end	5,640	5,640	5,640	5,600	5,260	4,810	4,260	3,430	2,410	1,080

The tangential force at any point "X" in a [illegible] by a force A applied at a point displaced [illegible] by an angle θ is equal to $A \sin\theta$, provided θ never exceeds [illegible] 90 deg. The total tangential force acting at any point in a ring is the sum of a series of forces within one quadrant on

Table V.

End forces.	A	B	[illegible]	D	E	F	G	H	K	L	[illegible]
4,180 A	352										
4,180 B	1,070	[illegible]									
4,180 C	1,715	1,070	352								
4,730 D	2,470	[illegible]	1,105	372							
4,270 E	2,770	2,230	[illegible]	[illegible]	335						
3,970 F	3,020	[illegible]	2,070	[illegible]	[illegible]	312					
3,750 G	3,200	2,850	2,440	[illegible]	[illegible]	875	[illegible]				
[illegible] H	[illegible]	3,050	2,720	2,325	1,870	1,370	[illegible]	281			
3,470 K	[illegible]	[illegible]	[illegible]	2,640	2,250	1,815	[illegible]	[illegible]	[illegible]		
3,440 L	3,430	3,350	3,180	2,940	2,620	[illegible]	[illegible]	1,320	[illegible]	270	
3,440 L_1		[illegible]	[illegible]	3,180	2,940	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3,470 K_1			3,460	[illegible]	[illegible]	2,960	[illegible]	[illegible]	1,815	1,330	[illegible]
[illegible] H_1				3,570	3,480	3,310	3,050	[illegible]	2,325	[illegible]	1,370
[illegible] G_1					3,740	3,650	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] F_1						3,960	3,860	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] E_1							[illegible]	4,160	[illegible]	[illegible]	[illegible]
[illegible] D_1								[illegible]	[illegible]	[illegible]	[illegible]
[illegible] C_1									[illegible]	[illegible]	[illegible]
[illegible] B_1										[illegible]	[illegible]
[illegible] A_1											[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table VI.

	Case I.			Case II.		
Positions.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
A	[illegible]	[illegible]	[illegible]	23,735	[illegible]	[illegible]
B	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
C	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
D	[illegible]	[illegible]	[illegible]	21,202	[illegible]	[illegible]
E	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F	[illegible]	[illegible]	[illegible]	21,760	[illegible]	[illegible]
G	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
H	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
L	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
L	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

one side of that point multiplied by the sines of the angles of displacement from that point. We shall find it convenient later if we obtain the tangential forces at points midway between A, B, &c. These points we will call A′, B′, &c., as shown in Figs. 2 and 3.

Table V. shows the tangential forces at various points due to the various radial forces at the core end for Case I.

The tangential forces may be found similarly for the outer end, Case I., and also for the core and outer ends, Case II., and are all shown in Table IV.

From the sums of the tangential forces given in Table VI. we can obtain the maximum load hoop stresses. The section of the cap-ring in both cases is 6·5 sq. in., by dividing the maximum sum of tangential forces for either case by 6·5 we obtain the maximum load hoop stresses.

$$\text{For Case I. we get } \frac{60{,}989}{6{\cdot}5} = 9{,}370 \text{ lbs. per sq. in.}$$

$$\text{For Case II. } \frac{59{,}531}{6{\cdot}5} = 9{,}160 \text{ lbs. per sq. in.}$$

It will be noticed that, although the total load in Case II. is only 93 per cent., that of Case I. the maximum load hoop stress for Case II. is very nearly the same as for Case I.

Were the load assumed to be evenly distributed the load hoop stress so obtained would have been 94 per cent. of the above value for Case I., and only 89 per cent. of that found for Case II.

C. We have obtained the values of the tangential forces at points midway between adjacent points of application of the radial forces. It follows if the resultant of two adjacent tangential forces on each side of any point is greater than the radial force at that point, that there will exist a reaction at that point equal to the discrepancy. If, however, the radial force be greater than the resultant of the tangential forces, then the ring will tend to leave the support at that point.

The resultant of forces at two adjacent points, since in this case they are very nearly equal—is the sum of each force multiplied by the cosine of half the angle between the tangents to the circle at these two points. Thus in our examples the angle subtended by two adjacent tangential forces is 171 deg. Thus, if two tangential forces be T_1 and T_2, the resultant is

$$R = \cos 85\tfrac{1}{2}\,(T_1 + T_2)$$
$$= [illegible]\,(T_1 + T_2)$$

The differences between the resultant and the radial forces as given in Tables III. and IV. are the sheer forces. These are given in Table VII. for Case I. and Table VIII. for Case II., but the forces with which we need concern ourselves are those [illegible]

Table VII.

Positions.	A	B	C	D	E	F	G	H	K	L
Core end	660	770	850	1,140	665	170	75	400	−635	−785
Outer end	1,170	1,405	[illegible]	[illegible]	[illegible]	[illegible]	180	−440	−1,125	−1,825

Table VIII.

Positions.	A	B	C	D	E	F	G	H	K	L
Core end	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1,595
Outer end	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2,130	3,830

[illegible]

$$[illegible]$$

[illegible]

$$[illegible]$$

Case I. has maximum stresses in the supporting lips similar to those shown in Fig. 1.

Core end.	3,060 lbs. per sq. in.
Outer end.	7,100 lbs. per sq. in.

Whilst for Case II. they are

Core end.	6,200 lbs. per sq. in.
Outer end.	15,000 lbs. per sq. in.

Such a calculation gives stresses greater than what they will be actually so that support lips shown are quite equal to carrying the load that may be put upon them, even in Case II. The magnitude of the shear forces show how inadvisable it would be to attempt to use cap-rings of wire, sweated together perhaps, without an accurate equalising of the load around the periphery at all points.

(To be concluded.)

"Emcol" Enclosed Motors.

Totally-enclosed motors have not met with the universal adoption which might be expected when the advantage of preventing dirt and dust accumulating in the windings is considered. It is well-known that the most frequent cause of breakdown of electric motors is due to an accumulation of dirt in that way. The wear and tear of the brushes on the commutator is greatly increased by dust and grit, and it is surprising how long the brushes will wear without renewal on a well designed motor if it is totally enclosed or otherwise kept quite free from deleterious matter. On the other hand, the heat generated in a motor must be dissipated by some means. When a motor is totally enclosed in the usual manner by providing coverings over the openings, the total surface of the motor is only sufficient to radiate about 40 per cent. of the heat generated when the motor is running as an open type-motor on full load, in consequence of which the output must be restricted under this condition

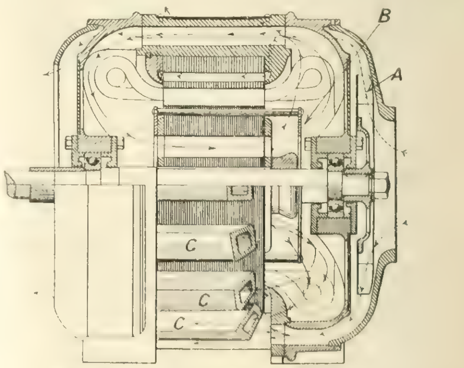


FIG. 1.—SECTION OF AN "EMCOL" MOTOR.

to 40 per cent. of the open-type output. In the case of large motors the reduction of output is still greater, and it is found that motors of 100 H.P. upwards are impracticable on account of their unwieldy size, weight and expense. This becomes evident when it is considered that the total heat which can be radiated from a motor is proportional to the surface of the motor, and it is obvious that this does not increase in the same ratio as the cubical contents of the motor, whereas the permissible output of an open type machine is roughly proportioned to the total volume. It is often noticed that the temperature rise for a totally enclosed machine is considerably in excess of that allowed for an open type machine, a condition which results from the attempts of manufacturers to put a totally enclosed motor on the market at a price which is not prohibitive. By doing this they neutralise to a great extent the advantage of enclosing, the high temperature being more destructive to the life of a motor in many instances, than would be the free access of air.

Attempts have been made to produce artificially cooled motors designed to prevent the surrounding atmosphere from having access to the windings, the pipe-ventilated motor being a well known instance, but this type of motor is not extensively used on account of the expense and difficulty in running the necessary trunking to a

supply of pure air, which, if obtained from outside the building, would cause moisture to deposit in the motor under certain conditions. From time to time other inventions have appeared in which air is circulated from inside the motor through various systems of cooling devices and returned to the motor after cooling. These devices increase the output, but they all require an apparatus of considerable size external to the motor so that the total bulk of the motor and cooling system is as large as or larger than the space occupied by a standard type enclosed motor, besides which there is the additional expense of the cooling system. Mr. P. A. H. Mossay and Mr. H. C. C. Jacoby have recently turned their attention to the production of a motor which would comply in every respect with the definitions of a totally-enclosed motor as defined by the Admiralty standard specification for electric motors for use in H.M. ships and with the British standardisation rules for electrical machinery. They have produced a motor, manufactured under the trade name of "Emcol," which is novel and practical, and for which they claim that the output for a given temperature rise is even greater than that of an open type motor of equal bulk and weight, the cost of manufacture being practically the same as that of an ordinary standard open type motor.

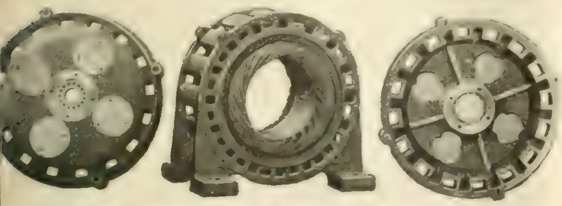


FIG. 2.—VIEW OF MOTOR WITH END COVERS REMOVED.

The chief characteristic of the invention is the circulation of the air inside the motor through a cooling system cast integrally with the frame in such a manner that the external dimensions are not appreciably increased. In the case of A.C. motors the cooling chambers are virtually channels cast in the webs which support the laminæ, so that the actual weight of a housing built according to this method is not greater than that of the ordinary standard motor. The cooling chambers are cooled by drawing cold air from outside through another series of channels ingeniously arranged so that the cooling air entirely surrounds the hot air chambers. An important feature of the invention consists in crossing over the two currents

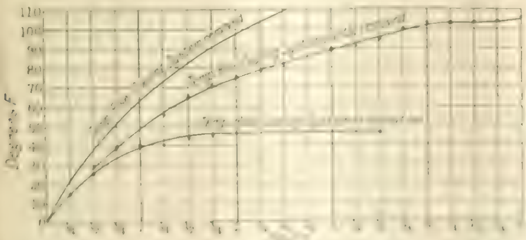


FIG. 3.—[illegible]

of air so that the cooling air [illegible]

[illegible]

[illegible]

Fig. 2 shows some of the details of construction.

In Fig. 3 are given the makers' results on a 10 H.P. three-phase motor, the electrical portion of which was a standard design for 10 H.P. four-pole open type 50 periods. This motor on a six hours full-load test showed a temperature rise of only 54° F. on the winding, the temperature of the air inside the motor being 46° F. rise. When overloaded to 14 H.P. the final temperature rise was 65° F. on the winding, the air inside being 59° F.

For purposes of comparison tests were taken on the same motor with the cooling system rendered inoperative so as to bring the motor under the condition of an ordinary totally enclosed motor. The results of these tests are shown by the annexed curves, and are for an output of 4 H.P. and for 5 H.P. load as compared with 10 H.P. load when the cooling system is in operation.

It should be explained that as the motor would only carry a reduced load under these conditions the voltage was reduced in proportion to the square roots of the loads so as to give the best efficiency on the reduced load.

The results are roughly summarised by the makers as follows:—

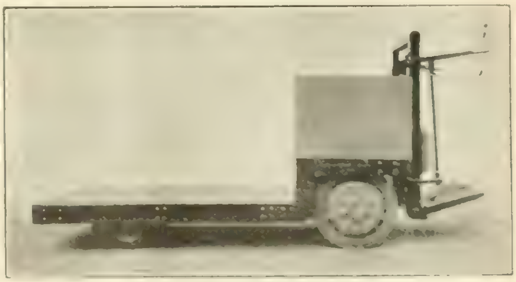
1. The output of an "Emcol" motor with a given temperature rise is the same or better than the output of a standard, open type motor of the same weight and bulk.

2. The output of the "Emcol" motor is 2½ times larger than the output of a standard totally enclosed motor of the same weight and dimensions.

We understand that the invention is fully protected by patents, and that the Enclosed Motor Co., Ltd., Finsbury-court, London, E.C., has been formed to deal with the patents, grant licenses, &c.

New Type "Hunt" Electric Industrial Truck.

The C. W. Hunt Co., of West New Brighton, N.Y.C., who for many years have been specialising on storage battery locomotives and industrial trucks, have recently brought out an improved type of truck, which we illustrate and describe below.



[illegible]

[illegible]

[illegible]

The points of interest in the truck are:—

First, the low loading platform, this being but 11 in. from the floor.

Secondly, the four-wheel steering which gives the remarkably small turning radius of 5 ft. 8 in. (measured outside the wheels), and which allows the truck being used on crowded shop floors, and to take sharp turnings in narrow passages.

Thirdly, the motor-in-wheel drive.

Fig. 2 shows one of these motor wheels opened out. This is known as the "couple gear," or balanced gear motor wheel, and is specially made for the industrial trucks of Messrs. Hunt by the Couple Gear Co., of Grand Rapids, Mich., U.S.A.

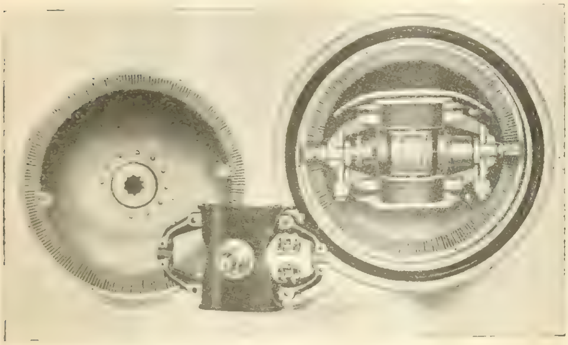


FIG. 2.—VIEWS OF INTERIOR OF MOTOR WHEELS.

It will be seen that a two-pole motor inside the wheel drives by bevel pinions on each end of its shaft the revolving housing, on the periphery of which the rubber tyre is mounted.

The magnetic circuit of this motor is divided vertically, and the right-hand illustration shows the motor opened out for inspection purposes. The removed portion of the magnetic circuit, together with brush gear and half bearings, is shown in the foreground of the illustration, on the front of which will also be seen the short stub axle on which the cover, with its crown wheel, revolves. This cover is shown on left of Fig. 2.

[illegible]

[illegible]

[illegible]

The Hunt truck motors have a gear ratio in these motor wheels of about 12—1, and we understand that the motors have given every satisfaction both in work and during the very extended severe trials they were put to before standardisation on the trucks.

Fig. 3 shows a three-quarter view of the truck with the controller handle on the right, coupled to the controller, and the steering lever on the left. The foot board shown is hinged and connected to a circuit-breaker, so that by the operator getting off the truck the circuit is opened. The brake pedal is also shown, and releasing foot pressure on this causes the band brakes to come into action.

FIG. 4.—VIEW OF TRUCK, SHOWING BATTERY.

Fig. 4 gives a side view of the truck showing the battery case opened, and gives a good idea of its accessibility.

The Hunt Co. have in progress a new type of elevating platform truck, built on similar lines to above, which will shortly be on the market.

All the Hunt trucks are of one capacity—viz., of 2 tons—and their ordinary flat platform trucks, types A and B, are built with platforms of 30 and 40 sq. ft. surface respectively.

Messrs. Irwin & Jones (Ltd.), of 3, New London-street, E.C., are the sole agents in the United Kingdom and France for Messrs. Hunt's productions.

Electrical Signalling and Control on Railways.

At the meeting of the Institution of Electrical Engineers on Thursday, Jan. 10, Mr. J. Sayers read Mr. C. M. Jacobs' Paper (abstracted in our last issue) on the above subject, the author being absent through bereavement.

Col. PRINGLE said three position signals should be experimented with more widely, and attention should be given to the development of the upper quadrant system and the use of the orange or some other third light. He agreed that electric lamp indicators were likely to prove more efficient than the delicate and unobtrusive mechanical type of repeaters. The reliability of the track circuit was of the first importance, and good would result from standardisation. He wished to put before the meeting requirements with which he thought train control systems should conform. A large majority of accidents were due to mistakes by signalmen or enginemen, and it was hoped by train control to obviate them. The enginemen had not only to watch signals, but to observe the road to avoid [illegible] deformation of track and so on, so the system of train control [illegible] not be of a type which would create a tendency to neglect observation of the road, for which reason he thought cab signalling was now [illegible] favour. If all the accidents were caused by failure to observe the warning or distant signals it would only be necessary to adopt a system to control at the warning signal, but probably half the accidents were due to mistakes resulted from misreading the home or starting signals. If an engineman knowingly passed a fixed stop signal at danger he would do his utmost by using the brake power to bring the train to a stand still at the earliest possible moment and if with a system of train control the same result could be obtained automatically [illegible] would have practical advantages sufficient to warrant the departure from the general theory, that interference with the driver was [illegible]. For that reason the effect produced by any system of control at warning and stop signals respectively should differ in degree. At a warning signal it should be left in the hands of the engineman [illegible] to increase the effect of the automatic brake application, according to the necessities of the case, but at a stop signal the train had to be stopped rapidly. In such circumstances it was preferable

that the control of the train should be taken out of the hands of the driver until the train was at a standstill. The adoption of the system on the Underground and Tube railways had not been found to minimise the sense of responsibility for observation on the part of drivers.

Mr. Roger T. Smith said the author remarked that "the disposition of the shoe and ramp, viz., in the centre of the running rails is the most practicable and convenient, and this may become a reason favouring the adoption of alternating current for railway electrification." He thought that was a little ambiguous. If direct-current electrification required the fourth conductor in the centre of the 4-ft. way, so also did the alternating-current system. The fourth or insulated rail originated in its being required for the protection of Greenwich Observatory, and other railways joining up with those which had previously been compelled to use the fourth rail were obliged to adopt it also. The L. & Y. and the L. & S.W. electrified lines had no fourth rail. If, however, the author meant that if direct current were used for signalling alternating current must be imposed for traction, it was a case of the tail wagging the dog. After the success of the L. & Y. line with the protected positive conductor rail running at 1,200 volts there was no reason why the comparatively short electrified lines in this country should not use direct-current of moderately high tension, utilising the running rails for the return current. If with the direct-current railway alternating current was a necessity for the track circuit he wished to ask the author whether the cab-signalling arrangement shown in the diagram in the Paper had yet been worked out for alternating current used on the ramp combined with a battery on the locomotive itself, which [illegible] necessary. If the scheme of power supply proposed by the [illegible] Sub-Committee were carried out it was likely that in the near future more alternating current would be available for such purposes as those, and he recommended signal engineers to occupy themselves with the question of the extended use of alternating current for track circuiting. Mr. Jacobs recommended much higher voltages than those hitherto in general use for track circuiting. He (Mr. Smith) hardly saw how those higher voltages could be arranged for unless by batteries, and they would have to be supplied by some general supply system, which would again fit in with the alternating-current supply for track circuiting. Enormous numbers of track circuit secondary cells were used, and he suggested that battery makers should pay the greatest attention to the production of a light battery which could remain on open circuit for the largest possible time.

Mr. A. Hurst thought the three-position signal was not free from that danger. As the diagram showed, the "all right" signal sloped downwards from right to left and the centre one of the lower three signals in the upper quadrant position sloped downwards from left to right, and in that position it was the same thing as the signal given for the opposite road in the all-right position. Consequently a driver was liable to mistake an all-right signal for the opposite line for a caution signal of his own line. It would be possible to design a simple form of signal free from that trouble. Orange was the colour which the greatest number of men could not see, the second was blue, the third green, the fourth violet and the last red. Clearly then, the orange light would be the worst that could be introduced for signals. The authorities of the Clearing House dropped the orange light as the result of his pointing this fact out to them some years ago. Mr. Jacobs said, "In the case of block signalling it should not be possible to [illegible] a signal in the 'proceed' position unless at the same time the signal in advance was at 'stop.'" That would not act. The farthest [illegible] first. The signalman pulled off the starting signal, then the home signal and last the distant.

Mr. [illegible] said he thought the signals the author had in mind were not at the same block post, but that one was at the home station post and the other at the next post.

Mr. Hurst said he was glad Mr. Jacobs [illegible] the use of common conductors. He (Mr. Hurst) was [illegible] of the first automatic signalling on the North Eastern Railway [illegible]. They had a common wire for about 10 miles, and [illegible] number of false indications. The author [illegible] many independent currents. [illegible] might be got by reason of two faults [illegible] lead to an accident. [illegible] independent batteries. [illegible]

[illegible]

extremes of the station limits and fed from the centre for track circuits, block circuits, point detection circuits, &c., a suitable resistance being provided where the branch current was led off from the main. A common positive run thus facilitated the system of having the function on the ground electrically repeated in the signal box. He agreed with the author that the shunt resistance in general use should be considerably increased. He did not like the term "ballast resistance" and certain other terms used in the Paper. The curves in Fig. 4 in the Paper showed 18 volts for a single track circuit, and this was a serious matter as regarded initial costs and maintenance. He had made a few calculations to show the performance of a 4·5 ohm relay, similar to those in use to-day under the same conditions as those given in the example. The minimum insulation of a track circuit was more likely to be 2 than 20 ohms. Take the case of a 4·5 ohm relay battery E.M.F. 1 volt. If you arranged for the maximum regulating resistance, viz., 5·396 ohms, then the maximum shunt resistance obtained was 11·25 ohms—well above the 10 ohms mentioned in the Paper. The power used with the 4·5-ohm relay was 0·03645 watt. The 4·5-ohm relay was therefore 50 per cent. more robust than the 240-ohm relay.

Mr. A. E. Gott expressed surprise that such low voltages were used in track signalling.

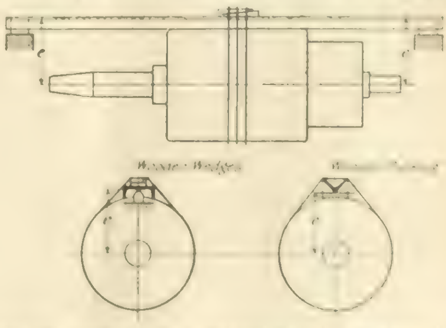
Mr. F. A. Lart said when he was at Crewe they tried all kinds of signalling, and he found all except the mechanical method too complicated. Automatic signalling on the cab of the engine or in the signal box might set up a standard of indifference, which might have disastrous results. The position of a signal could be communicated to a driver by purely mechanical means more certainly than by any electrical installation. With the mechanical system the temperature might alter the length of a wire and make it difficult to make a signal come off, and he had known instances where it was doubtful whether a signal was on or off. He did not admit, however, that this disadvantage outweighed the difficulties of the other systems.

Mr. H. M. Proud said he did not wish any members of that Institution who might not be familiar with track circuits to get from the Paper an impression that track circuits were not safe. Mr. Thorrowgood had shown that a 4·5-ohm relay could give the same shunt as Mr. Jacobs [illegible]

The Determination of the Moment of Inertia of Armatures.*

By W. WELSCH.

The usual methods of measurement of the moment of inertia of armatures require special apparatus, such as ball bearings, auxiliary pendulums and weights. It is possible to use the armature itself as a pendulum of short length. If a bar of iron of T or L section is bound to the armature by a rope as shown in the figures, the armature may be mounted so as to hang as a pendulum and oscillate about two knife edges in the first instance, or about the edge of the L section of the iron supported on a flat plate of iron. In this way, even with roughly made supports, it is possible to obtain a long



[illegible]

[illegible]

* [illegible]

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Labour During 1917.

The relations of Capital and Labour during 1917 have necessarily been quite abnormal, but many events have taken place of more than usual interest, and which must be borne in mind in looking at the future of British industry. The "dilution" of labour has continued to an increasing extent, the chief feature in this direction being the very large employment of women on skilled work. It is not too much to say that women have shown their ability in this respect to a far greater extent than was ever anticipated. This is due to two causes. The first is that they were given careful preliminary training under skilled workers, and, although the time so spent was short, the tuition was so arranged that reasonable skill was obtained in some particular branch of work. The second reason is that women are employed exclusively on repetition work, and consequently they are able to acquire a degree of skill which would be quite impossible if they were required to undertake the varied work carried out by skilled men. Exhibitions of work by women have been a source of surprise to those who have not been in touch with this movement.

The past year has shown the importance of the question of fatigue in industrial work. At the outbreak of war the hours of labour were very much extended in order to cope with the demands for munitions, and not only was work carried out on ordinary days of the week, but on Sundays also. Investigations have shown that this is a mistaken policy. Overwork merely leads to inferior results in both quality and quantity. This is borne out by an interesting report by Dr. H. M. VERNON to the Health of Munition Workers' Committee. From observations extending over a period of 13½ months, it appeared that a reduction of working hours resulted in an increase of production, both relative and absolute. Observations were made on the workers engaged on the making of fuses. A reduction of a 12 hour day to a 10 hour day showed an increase in gross production of 11 per cent., and the gross production was nearly as great when the actual working hours were reduced to 15.6 hours per week.

Labour Unrest.

It is not unnatural that the state of war should have created a certain amount of "labour unrest." In order to investigate this matter, Commissioners were appointed for a number of districts in June, and they reported, with a unanimity of outlook, in July. These reports, generally speaking, showed that such unrest was due chiefly to the high prices of food, to restriction of personal freedom, to lack of confidence in the Government, and to delay in the settlement of disputes. Lack of confidence in the Government was due to the idea that the Trade Union rules which have been set on one side during the war would not be restored after the declaration of peace to their previous status. This idea, needless to say, opens up a very large subject on which the whole welfare of the country and of the workers will depend. Dissatisfaction at the restriction of personal freedom was due to the fact that workers in munition factories could not leave their employment without a "leaving certificate." This cause for dissatisfaction has now been removed by the abolition of these certificates. From the point of view of removing discontent this may be a highly desirable course, but from the point of view of industry the case is by no means so clear, for it places firms engaged in Government work, and also Government factories themselves, in a very advantageous position as compared with other firms who may find themselves unable to compete for labour on an uncommercial basis.

Trouble has also arisen with the lower grades of staff in certain industries, and with skilled men, owing to the award of increase in wages being on a restricted basis. The difficulty has arisen through the most highly skilled men, upon whose work the piece-workers depend, being unable to earn anything like so much as the unskilled workers engaged on such work. It was a legitimate grievance, and these men were awarded an advance of 12½ per cent., but the same advance is now being claimed by many others. So far as we are aware, the present claimants are not in the same position, and thus their action is not justifiable, but there is, no doubt, some difficulty in drawing a line.

During the year the dealings of Labour have chiefly been with the State rather than with Capital, for the greater number of firms, at least in the engineering trades, are now controlled firms, and therefore such matters have been taken out of their hands. The object of Capital has not been so much to deal with Labour at the present time, as with the aspects of trade in the near future, and with the relations of Labour when peace comes. Undoubtedly the future of British trade presents enormous problems. For this reason we are glad to see that the Federation of British Industries has made very considerable progress. According to a recent statement, it now represents over 2,000 millions sterling of capital. The home trade and foreign trade, however, form merely one aspect of the case. The relations of Capital and Labour are equally important (or we may say, advisedly, more important), for unless these become cordial in the future the economic position of the country can only be unsatisfactory, not to say ruinous, to both Capital and Labour. At the present time there is a tendency on the part of such bodies as the Federation of British Industries to approach Labour in a conciliatory way, and we trust that Labour will respond so that there may be a frank understanding on both sides.

The question of machinery for maintaining a better understanding between employers and employed formed the subject of a most important report on Joint Standing Industrial Councils (generally known as the Whitley Report), which was issued in July, by a Sub-Committee of the Reconstruction Committee. This report recommends the creation of works committees representative of the management and of the workers jointly, and of district and national councils representative of the trade unions and of the employers' associations in each industry. The report has in general been favourably received by both employers and employed, and in October it was approved by the War Council. Much remains to be done, no doubt, from the point of view of the education of both employers and employed. In this direction work is being undertaken by the Industrial Reconstruction Council, a body which has recently been formed to advocate councils on the lines of the Whitley Report and to promote other steps of this kind.

That rapid action is desirable in this direction was rendered evident by the recent regrettable strike of aeroplane workers at Coventry. Here the shop steward system has been in operation, but has not been approved by certain of the trade unions. The shop stewards were not, therefore, recognised by the employers. An agreement has now been reached in the matter, and it is to be hoped that no further

disputes of this kind will occur. They seem to be particularly uncalled for at the present time, when so many steps are being taken to create committees and councils of the kind suggested by the Whitley Report.

RECONSTRUCTION PROBLEMS.

Both trade and labour questions have been under consideration by the Reconstruction Committee, which was originally appointed by Mr. ASQUITH to advise the Government on the problems which will arise at the end of the war. This Committee has now been reconstructed with the PRIME MINISTER as chairman, and out of the work of the Committee has no doubt been evolved the Ministry of Reconstruction, with Dr. ADDISON as the first Minister in this position. Among the many problems which this Ministry must consider is that of demobilisation. We were glad to note that Dr. ADDISON in September was able to state that real progress had been made in arrangements for dealing with the large numbers of men who will eventually be set free from the army.

A problem which will no doubt become more and more urgent as time goes on is the employment of disabled men. Our sympathy naturally goes out towards men who have risked so much for those in this country, and who have suffered much; and from this point of view every effort should be made to find employment for them, and to make life easy for them. We fear, however, there is a tendency to create difficulties in more than one direction. In some cases the men who are not disabled have raised objections. It appears also that the disabled men themselves are sometimes inclined to expect too much on their side, and the employers are sometimes not inclined to give way quite as much as they might on theirs. We fear, with the best will in the world, that the disabled man who is receiving a pension must not expect to receive the same wages as his able-bodied competitors, not by reason of the pension, but because of handicap by disability. On the other hand, employers must exercise some patience in dealing with the matter. In some cases at least, disabled men have been employed with most satisfactory results, as can be seen by reference to our columns.

Another direction in which Labour is vitally interested is in education in its broadest sense, that is, in the education of children and apprentices. An important indication of progress was the Bill introduced by Mr. FISHER, Minister of Education. This was a remarkable advance on previous measures, but it was eventually withdrawn owing to opposition to the administrative details that were suggested. The Bill recognised that the employment of children below the age of 12 should be prohibited, and that half-time exemptions below the age of 14 should cease. What was still more important, however, was the provision for the continuation of education by compulsory attendance at continuation schools up to the age of 18 for those who had not a full-time education up to 16 years. Another Bill on these lines has this week been introduced, and we gather that the more contentious matters have now been omitted.

In October the Labour Party proposed a re-organisation so as to place the Party upon a very much wider basis. The effect of the re-organisation would be to throw the Party open to all workers by brain as well as by hand. The admission of the brain worker is important; it shows an appreciation of brain work which has not been apparent hitherto. The present is essentially a time for self-education, and we trust that full advantage will be taken of the opportunities now offered, so that both Capital and Labour will adopt the broadest possible view of the problems with which they will be confronted in the near future.

Reviews.

Electric Traction: A Treatise on the Application of Electric Power to Tramways and Railways. By A. T. DOVER, A.M.I.E.E. A.A.I.E.E. (London: Whittaker & Co.) Pp. xiv. + [illegible]. 18s. net.

The preface of this book informs us that it is intended for engineers and advanced students, and, in spite of its few shortcomings, it may be recommended to either class with confidence as the best extant work on the subject. It is comprehensive and sufficiently detailed, clearly written, logically arranged, free from serious errors and well provided with references; it is, moreover, well printed and is illustrated with a large number of drawings, diagrams and half-tone views. The book is principally a compilation, and a reader familiar with the technical literature of the subject will find in it little original matter, although the author shows himself quite capable of elaborating his own methods of treatment. Like most engineering text-books, it makes somewhat tedious reading, for although clear in expression, the style is lacking in distinction.

The author is quite impartial in his treatment of the several themes discussed, and uncritical of the methods described: from these characteristics arise, perhaps, the chief weakness of the book as judged from the engineers' viewpoint; the author concerns himself too exclusively with what has been done and rarely indicates what has been found to give the best practice. What has been done, however, is frequently of the nature of experiment and is not repeated. The double catenary may be cited as an instance. It was first used on a service scale on the Hamburg-Altoona line, but was found to offer no advantages over the single catenary to justify its greater cost; it, therefore, became obsolete at once in Continental practice, although doubtless still giving satisfaction in operation. Far from indicating this, however, the author devotes as much space to the double as to the single catenary, and even attributes to it advantages which it does not really possess.

The book is divided into 27 chapters. An introductory chapter on general matters is followed by a couple on the mechanics of train movement, and from their title and position it would seem that the author has taken to heart the present writer's implied admonition * to compilers of text-books on electric traction. These chapters give a good preliminary discussion of the subject, leaving fuller treatment for Chapters XVIII. and XIX. It is very doubtful, however, whether the author is justified in his statement (p. 29) that "when the speed is changing rapidly the train resistance is greater than that at constant speed"; even if this were so it would be practically impossible to determine the fact.

Chapters IV., V. and VI. deal respectively with continuous-current traction motors, single-phase traction motors, and polyphase traction motors, discussing their design, mechanical and electrical features and operating characteristics. Although not exhaustive, these chapters furnish excellent general guidance to this part of the subject. In particular, the author shows very clearly why series characteristics are superior to constant speed characteristics for traction work, an important and frequently misunderstood matter. Chapter VII. deals succinctly with the testing of traction motors; [illegible]

[illegible]

* [illegible]

[illegible] discussion to a few types. The chapters in question are more comprehensive, treating with sufficient [illegible] all types of [illegible] that have been used. The [illegible] makes no mention of the important recent installation on the locomotives of the Chicago, Milwaukee & St. Paul Railroad. The [illegible] chapters deal with auxiliary equipment [illegible].

Chapters XV., XVI., and XVII. deal [illegible] with the rolling stock for electric tramways, the rolling stock for electric railways (motor-coach trains) and electric locomotives. These chapters are principally descriptive, and deal with the subject with the painstaking thoroughness which characterises the book. Chapters XVIII. and XIX., as stated above, deal with general mechanics, but why these are inserted between the locomotive and the track is not quite clear; Chapter XVIII. deals with train resistance, whilst Chapter XIX. goes fully into the subject of the calculation of speed-time curves and energy consumption. A slip occurs on page 415, where, speaking of dynamometer cars, the author says that "the train resistance is obtained from the product of the draw-bar pull and the speed," for, of course, the draw-bar pull is itself the train resistance.

Tramway tracks form the subject of the next three chapters, whilst Chapter XXIII. deals with conductor rails and track-work for electric railways. This is followed by two chapters on overhead construction, the first for tramways and the second for railways; these give methods for computing the sag and tension of a wire as affected by temperature, but the author's statement (page 522), that the fact that it is necessary to consider the elasticity of the wire, was first pointed out by Prof. B. Hopkinson, is in all probability an injustice to our forebears, and, in any case, is an unnecessary sort of reference, as the fact must be patent to anyone competent to deal with the subject. It may be mentioned also that the stiffness of a trolley wire prevents its hanging strictly in a pair of catenaries from the ears. The penultimate chapter deals with feeding and distributing systems for tramways and railways, whilst the final chapter [illegible] converting machinery and switchgear for continuous-current tramways and railways.

The book has also three appendices, a collection of examples from examination Papers, an index, and, finally, a number of folding plates.

F. W. CARTER.

Examples in Magnetism for Students of Physics and Engineering. [illegible] (London: E. & F. Spon.) Pp. [illegible]

The object of this book is to furnish a guide for students in technical schools and colleges who are beginning the study of [illegible] into 12 lessons, of which the first four (pp. 7-27) are introductory and deal [illegible]. The remainder [illegible] magnetic force, [illegible]

[illegible] furnished, the data [illegible]. Each example is followed by a "Problem" of a similar nature to which the answer is supplied [illegible] to be solved without [illegible] examples [illegible] a collection of [illegible] conclude [illegible]

[illegible] reduced [illegible] the [illegible] the diameter [illegible]

[illegible] in a second [illegible] publication.

B. W. C.

A "Density-Cell" with Slight Local Action.*

By Prof. CH. FERY.

Of the numerous combination batteries which have been devised to-day there is scarcely any type in practical use, except those utilising salammoniac, which have the valuable property of remaining in good order for long periods of time, always available for use, and requiring relatively little supervision. The use of this type is especially prevalent in cases where only feeble currents are necessary, or where there are long periods of rest, *e.g.*, in connection with telegraphy and telephony, electrc bells, safety appliances on railways, &c.

The chief requirement in such batteries is slight local action. Theoretically zinc, either pure or amalgamated, is only very slowly attacked by a solution of salammoniac; but in practice it is found that the consumption of this metal is out of proportion to the ampere-hours taken from the cell. Moreover, experience shows that the consumption of the zinc rod, which in general forms the negative electrode in these cells, is irregular and is cheifly confined to the surface at the points in immediate contact with the level of the exciting liquid.

The experiments now to be described were designed to provide a remedy for such irregular local action. They were undertaken previous to 1914, but publication has been deferred until the experience of one of the chief railway companies was available.

I was originally under the impression that the consumption of the zinc at the surface of the liquid might be due to the combined action of the oxygen in the air and the liquid, capable of dissolving the oxide formed. It is known, for example, that in the case of accumulators the negative sulphates rapidly when exposed to air, according to the relation :—

$$H_2SO_4 + Pb + O = PbSO_4 + H_2O.$$

For this reason the surface of the plates should not be uncovered. However, it was always found that a plate of zinc allowed to stand alone for several months in a vessel containing a solution of salammoniac was scarcely more attacked at the surface than at the bottom of the liquid; in the course of four months the thickness of the plate was studied from top to bottom and the difference in thickness noted was about 0·05 mm.

Now in the normal operation of a cell chloride of zinc is formed, the solution of which is denser than that of the salammoniac. If the elements of the cell are arranged in a glass vessel with parallel walls and strongly illuminated by electric light one can perceive marked striations which fall away from the zinc and reform at the bottom. Moreover, round the positive electrode the light ammoniacal solution arising from the electrolysis of salammoniac can be seen rising to the surface. It was, therefore, natural to inquire whether the zinc rod which is in contact with these various liquids does not form a mono-metallic element.

In order to verify this second hypothesis some weak solution of ammonia, in the proportion of 1 : 100, was gently added to the vessel containing the plate of zinc referred to above. In this way the conditions that occur in practice in respect of the zinc rod could be reproduced. The next day I was able to detect on the lower portion of the plate a granular deposit of zinc, while the upper portion was clearly attacked. The following experiment showed the nature of the E.M.F. that arises in this circumstance. A porous vessel containing a neutral solution of zinc chloride was placed in a glass vessel containing a solution of ammonia; two identical electrodes of [illegible] introduced in these two liquids, showed a potential difference of [illegible] volt. On short-circuiting this mono-metallic element a [illegible] deposit of zinc was observed on the plate immersed in zinc chloride, while the other plate was attacked, furnishing ammonium [illegible].

These experiments prove that the decomposition of the upper part of the electrodes is not due merely to the effect of atmospheric oxygen, but to a secondary electrolytic action occurring to the [illegible] where the electrode comes in contact with two dissimilar liquids.

While it may appear superfluous to discuss in detail the reactions [illegible] place in the well-known salammoniac cells, it must be [illegible] that secondary reactions often play an important part in [illegible] of materials which are left unused for a long time. In order to [illegible] this point a special cell was made up, as shown in Fig. 1, and [illegible] continuously to a resistance of 80 ohms. A carbon tube [illegible] placed centrally in the vessel, its bottom being insulated from [illegible] plate Z by a layer of felt F. The vessel contained [illegible] of ammonium chloride solution (8 parts in 100). At the end

* Abstract of a Paper read before the Société Internationale des Electriciens.

of a fortnight the well-known crystals of ammoniacal zinc oxychloride appeared on about one-third of the submerged portion of the carbon tube. A strip of Litmus paper showed red below the crystal region and blue above it. The battery cell gave off a strong odour of ammonia. The crystals are produced at the junction of the heavy zinc chloride solution and the lighter ammonia solution, thus showing that ammonium chloride dissolves them less readily than either of the liquids to which its decomposition gives rise.

The density of the liquid at the bottom of the cell was found to be 1·103, and above, at the upper surface, only 1·076. If a cell of this kind is agitated ammonium chloride is reformed according to the relation :—

$$ZnCl_2 + 2NH_4OH = 2NH_4Cl + Zn(OH)_2.$$

The next day after this the whole of the surface of the carbon, as well as that of the vessel, was covered by small brilliant crystals. But if the pile is again set in action and allowed to remain untouched the crystals disappear everywhere, except in the neutral zone, referred to above. New conditions are produced by the action of the cell. This is not the case, as is well known, in a Daniel (copper sulphate) cell, where the primary and denser solution tends to become continually weaker, while the lighter solution originally situated near the upper surface gradually increases in density. Reversal of the two solutions is thus inevitable and reveals itself by the deposit of spongy copper on the zinc.

Depolarisation of cells of the salammoniac type is very rapid and the cell readily regains its normal E.M.F. on open circuit, which it possessed previous to polarisation. The effect of the depolariser, the oxygen from the air which dissolves readily in the upper level of the liquid, always yields the same results. In cells utilising manganese on the other hand, the cell can never regain its original

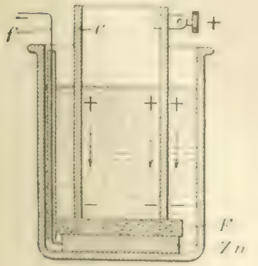

FIG. 1.

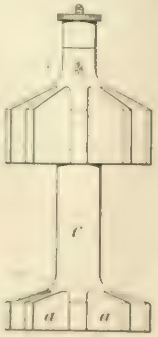

FIG. 2

energy after a short circuit, for the chemical constitution of the depolariser has been meanwhile altered. If one opens the circuit of the voltaic pile, illustrated above, the carbon tube, strongly polarised in its lower part which is adjacent to the zinc, is, on the contrary, almost destitute of hydrogen in the upper region where the stream lines are less intense. As soon as the circuit is broken the carbon tube may be regarded as a kind of cell with hydrogen and oxygen as two elements, which is short circuited on itself. The currents circulating in the direction of the arrows (see Fig. 1) establish themselves between the two extremities of the electrode, tending to make its potential uniform; these currents may fitly be termed depolarisation currents. They cease when the limited amount of hydrogen carried by the electrode is [illegible] by the unlimited quantity of oxygen surrounding the upper part of the carbon.

From the practical [illegible]

to the strength of the current, the concentration and the temperature and contain carbonic acid as a constituent, showing beyond doubt the carbonisation of the air at the surface of the ammoniacal solution.

In order to compare the results obtained from this special form of cell with those yielded by the ordinary arrangement in which the zinc occupies the entire height of the vessel, *I*, a second cell, with conditions otherwise identical, was prepared, but with a zinc in the form of an inverted U, so as to [illegible] both faces of the carbon tube. At the end of 15 days the voltage P.D. of the ordinary cell had fallen to 0·6 volts, while the P.D. of the special cell took 33 days to reach the same value.

Experiments have been carried out on carbon electrodes in the form of a grooved cylinder, the grooves being only 3 mm. in depth; the zinc consisted of a rolled strip surrounding the foot of the carbon but insulated the reform by a few turns of small cord.

I would have liked to have used carbons with wings, somewhat in the form shown in Fig. 2, with a view to increasing the depolarising surface. Cutting away the electrode at the centre should be favourable to the depolarising currents. It is also necessary to bear in mind that the resistivity of sal-ammoniac solution is about 2,000 times that of carbon, and it is therefore beneficial to increase the superficial area. Finally this form of electrode besides permitting the use of a larger volume of exciting solution had the advantage of allowing the crystals to deposit on this narrowed central portion of the carbon. Being, however, unable to obtain such carbons at the present time, I have, as stated above, utilised grooved carbons, about 42 mm. diameter.

The cells I., II. and III., the results obtained from which are shown in the following table, had one of these carbons for the positive, only the zinc being differently arranged. I. was furnished with a zinc annulus placed round the lower part of the grooved carbon ; II. had an identical zinc with I., but placed 1 cm. below the level of the liquid ; III. had a cylindrical zinc, similar to that employed in ordinary cells.

Table I.—*Diminution in P.D., with time, of Cells I., II., III. and IV.*

Days.	I. Volts.	II. Volts.	III. Volts.	IV. Volts.
0	0·94	0·94	0·84	0·98
10	0·84	0·78	0·70	0·88
20	0·82	0·77	0·65	0·90
30	0·82	0·76	0·60	0·92
40	0·80	0·73		[illegible]
50	0·78	0·72	Experi-	0·88
60	0·74	0·67	ment	0·88
70	0·74	0·60	stopped.	0·88
80	0·75	0·58	...	0·86
90	0·74	[illegible]		0·86
100	0·73	0·61		0·82
110	0·72	0·61		[illegible]
120	0·70	0·62		0·86
130	0·68	0·62		0·86
140	0·66	0·62		0·86
150	0·64	0·62		0·86
160	—			[illegible]
170	—			0·84
180	—	—		0·84
190				[illegible]
200				0·82
210				0·82

The three cells I., II. and III. utilised the same volume of sal-ammoniac solution, at the proportion of 12 [illegible]

[illegible] is only 0·02 [illegible]

Zinc [illegible]

precipitation of zinc hydroxide and regeneration of the exciting salt. The P.D. also rose from 0·82 to 0·85 volt. The zinc removed during this period of 7 months was 1·24 gms. per ampere-hour, the theoretical value being 1·228 gm.

In the cells using the cylindrical zinc the consumption occurred chiefly in the upper region. In the case of very light discharges (*e.g.*, 4 ampere-hours per year) I have even observed that in cells in which the cylinder is placed rather high (5 cm.) a deposit of crystalline zinc occurs on the lower part of the cylinder, whereas the upper region is dissolved away. The explanation of this apparent paradox was given earlier. This confirms the statement that forms of zinc plate placed at the base of the vessel is most advantageous.

It is next proposed to describe an arrangement enabling the power derived per weight of the cell to be increased. In the bottom of the vessel a horizontal plate of zinc, occupying the entire base, is mounted. On this plate rest, separated by two insulating wedges, the carbon electrode, which takes the form of a large number of plates in the

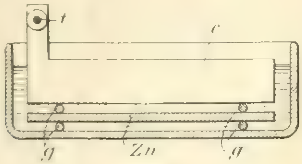

FIG. 3.

form of an L; these plates are connected by a central metal rod. Figs. 3 and 4 show views of this arrangement. A small model of this type, mounted in a vessel 9 by 12 and containing a zinc with 100 sq. cm. surface, and with 10 carbon plates, gives on short circuit 2·5 amperes. This cell has furnished a very regular discharge of 0·25 ampere for 24 hours.

Some experiments were made on the E.M.F. of a cell of type I. The external diameter of the carbon was 60 mm. and the internal diameter 50 mm. These measurements refer to the conditions after the cell had been in use for a month and a half, the cell being connected to 80 ohms. Crystals had formed on the carbon by the end of [illegible] month. During the above period the cell had furnished 11 ampere-hours at a P.D. below 0·94 volt.

When put on open circuit for 24 hours the E.M.F. was found to be 1·22 volts. The same experiment was repeated with a series of

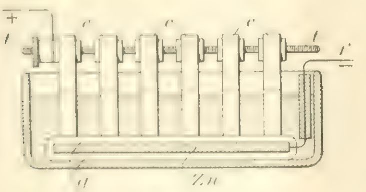

FIG. 4.

[illegible] connected to the terminal of the cell, the [illegible] being subsequently [illegible] in the reverse [illegible]. The following are the results obtained:—

[illegible]	[illegible]	E.M.F.
[illegible]	[illegible]	1·19
[illegible]	[illegible]	1·024
98 ..	[illegible]	0·92
[illegible]	[illegible]	0·88
31 ..	[illegible]	0·83
19 ..	[illegible]	0·70
[illegible]	[illegible]	0·48

[illegible] is to be remarked in the second column, but, [illegible] about 12 days [illegible] to within [illegible] of [illegible] E.M.F. on open circuit. The instantaneous [illegible] very light and [illegible] internal resistance of [illegible] 0·6 ohm. It is of [illegible] that after a rest the cell is capable of making a relatively strong momentary effort, a [illegible] which is of [illegible] when it is used for intermittent work.

[illegible] cell previously referred to gave [illegible] amperes on short circuit, [illegible] the polarisation is naturally very rapid. [illegible] the other hand, the depolarisation is also rapid, as is shown by

the following data relating to the rise in voltage on open circuit of a cell which had been connected to a resistance of 80 ohms:—

H.	M.		Volts.	H.	M.		Volts.
9	8	on 80 ohms	0·880	10	1	on ∞	1·12
0	9	on ∞	0·990	10	1	on 80 ohms	0·93
0	10	.. ..	1·02	0	2	.. ..	0·92
0	11	.. ..	1·04	0	3	.. ..	0·919
0	12	.. ..	1·045	0	5	.. ..	0·905
0	15	.. ..	1·06	0	15	.. ..	0·900
0	30	.. ..	1·09	0	30	.. ..	0·895
0	45	.. ..	1·11	11	0	.. ..	—

It will be seen that after a rest of 50 minutes the voltage on open circuit has returned to within 7 per cent. of its normal value.

A comparison of local action under practical conditions was made between these special density cells and those using manganese. Four manganese cells and four of the density-cells were mounted in series and connected continuously to a resistance of 700 ohms, the average current being 12 milliamperes. At the end of five months the cylindrical zinc in the manganese cells had to be discarded, and when 230 days was reached (after which the experiment was stopped) they again had to be replaced, being very strongly attacked near the surface of the liquid. The explanation of the more rapid wasting during the latter stage of the experiment will be understood from what was said in the early part of this Paper. At the end of five months the change in quality of the liquid in the manganese cells was complete, after which the effect of the parasitic electrolytic actions was correspondingly severe.

The zincs in the density-cells, throughout this period, wasted quite regularly, and were almost completely used. From this practical test the result emerges that, for the same capacity of discharge two electrodes, each containing 150 grammes of zinc, were used in the manganese cells, whereas the density-cells only required one electrode of 110 grammes. The former thus consumed 5·5 grammes of zinc per ampere-hour as compared with only 1·96 in the case of the latter.

Correspondence.

SCIENTIFIC COSTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Howard F. Smith in his letter deals with a subject which has always been of great importance, but which in the future will play a yet greater rôle in works management. Exact measurements form the basis of all exact science; in scientific manufacturing the costing constitutes the basic measurements. It is surprising to find how many men holding important positions in industry have no proper idea of the elements of cost keeping. Costs are looked upon by these people as figures to be estimated from time to time, and as variable quantities depending upon arbitrarily chosen formulæ, giving the relationship between material and labour and the total works cost. Now the works cost of a manufactured article is a fixed quantity each time it is produced, just as, for example, is its weight, and cannot be varied by any form of book keeping or the like. Each time the article is made the cost should be forthcoming, so to say, automatically, and should serve the management as a criterion of the efficiency or otherwise of the works. The costs should be the basis of the works accounts, which should show from week to week the profit or loss being made.

The subject of costing is intimately bound up with the great problem in front of the engineering industry, the establishment of a really satisfactory system of "payment by results." Compared, for example, with the textile industries, the engineering trade has a lot to learn in this matter. In these trades disputes as to piece work prices and the like are practically unheard of. On the other hand, engineering, owing to its great variety, constitutes a more difficult problem; it is one, however, which is not beyond the capacity of engineers to solve if they will give the needful study and attention to it.

The intimate connection between costing and "payment by results" is due to the fact that, in the future, competition as a means of adjustment of prices and wages will be of much less effect than heretofore. This will be the result of the combination of employers and employees and the beneficial co-operation of the industrial councils which are being set up

in accordance with the Whitley Report. In the past the inefficient firm or workman was obliged to improve by the force of competition. With a co-operative industry this will be to a great extent removed and another test of efficiency must be found. This will be provided by the cost keeping.

In your leading article this week you deal with the important subject of standardisation of machinery. As regards cost keeping, however, standardisation will be required just as much. The subject is being dealt with from this point of view in the United States. The Federal Trade Commission there issued in 1916 a publication entitled "Fundamentals of a Cost System for Manufacturers." This can be obtained from the Government Superintendent of Documents in Washington. At the present time, moreover, a special committee representing the largest American electrical manufacturing concerns is at work upon the production of a standardised accounting and cost system for the electrical manufacturing industry. It would be a very good thing if something on the same lines could be done here. Perhaps the British Electrical and Allied Manufacturers' Association could take the matter up.—I am, &c.,

Sutton Coldfield, Jan. 11. CHARLES C. GARRARD.

A PLEA FOR STANDARDISATION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read the leader in your current issue with much interest, and am only sorry you have not extended your arguments to include the advisability of standardisation from an international point of view. Had you done so you could not have omitted to include references to the important bearing which our delay in adopting the international metric system has upon this vital question.

You have no doubt seen a very excellent Paper by Mr. Herbert T. Wade, entitled "The Metric System and International Standardisation," which was presented at the annual meeting of the American Metric Association, held at Pittsburgh on December 28-29, 1917.

Mr. Wade very truly says :—

> With international standards duly established, a manufacturer could then produce for a foreign market without any special changes of equipment or of types of product, and at the same time any surplus over that required for home consumption could be more readily disposed of abroad, if made to a standard that would meet also the requirement of distant [illegible].

As mentioned in the course of my contribution to the recent I.E.E. discussion on the metric system, I feel that our adoption of the metric system has become [illegible] as a national necessity, and when the nation as a whole is in a position to turn its attention from the preoccupation of active war to the less stimulating necessity of paying for it I am confident the Government will appreciate that all legitimate steps, such as the adoption of the metric system, must be taken without delay in order to assist us to alleviate the burden of taxation by the exportation of British manufactured goods in enormously increased quantities.—I am, &c.,

Manchester, Jan. 11. HARRY ALLCOCK.

THE PRODUCTION OF DUCTILE TUNGSTEN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As solicitors for Duram Limited, the well known manufacturers of ductile tungsten for filament lamps and other purposes, our attention has been called to the letter of Mr. John Gray in your issue of December 28th and to his statement that "British Thomson-Houston Co. were supplying their whole requirements of ductile tungsten for Mazda lamp filaments in 1912 by manufacture at their Rugby works."

Mr. Gray's statement will be received, no doubt, with amusement by many lamp manufacturers in this country; but there is really no excuse for the inaccuracy of his statement, inasmuch as Mr. Fraser, the secretary of the British Thomson-Houston Co., in an affidavit filed by him in the action brought by that company against Messrs. Duram Limited for infringement of their patent No. [illegible], of [illegible], which action was dismissed by Mr. Justice Astbury and the Court of Appeal, swore that between October 1, 1912, and September 30, 1913, the total production of tungsten wire drawn at Rugby, as evidenced by the production sheets, was 5,835,686 ft., of which more than two-thirds—viz., 3,824,247 ft.—were drawn from tungsten rods and coarse wire imported from the General Electric Co. of America.

The total production of finished wire manufactured and drawn in its entirety at Rugby was only 2,011,839 ft., and the value of much of that for lamp-making purposes can be appreciated, since the production sheets show that quantities of this were in lengths of less than 100 ft.

Allowing for wastage only 20 per cent., which would be very generous at that date, and allowing 3 ft. to a lamp, the British Thomson-Houston Co. only made wire in its entirety for 536,490 Mazda lamps during the period mentioned. It will, in addition, be noted that this period includes nine months of 1913, whereas Mr. Gray speaks of 1912, when his company could hardly have been more successful.

Having had his attention called to the matter, Mr. Gray would not wish us to omit to notice that the secretary also admitted the importation of lamps from America during the same period.

Having proved the inaccuracy of Mr. Gray's statement, we may be permitted to add that our clients, Messrs. Duram Limited, are, and have for some time past been, manufacturing millions of metres of drawn tungsten wire at Hanwell, and are far more competent to supply the whole of the requirements of the United Kingdom than the British Thomson-Houston Co.—We are, &c.,

10, New-square, London. SPEECHLY, MUMFORD & CRAIG.
Jan. 15.

[We regret that pressure on our space compels us to hold over some correspondence.—ED. E.]

Education and the Federation of British Industries.

The Education Committee of the Federation was charged by the Council with the general consideration of the education of the country and its relation to the improvement of industrial efficiency, and a statement has now been issued on the subject. The statement has particular reference to Mr. Fisher's recent Bill, which was withdrawn.

[illegible]

[illegible]

be taken out of working time. The Committee strongly recommend that organised games should be included in any scheme.

The Committee feel that it is most essential that any extension of the time devoted exclusively to education should be very gradual in order to allow the necessary adjustment to be made in the labour markets. At the same time they would very strongly advise that in selecting children for higher education care should be taken to avoid creating as was done, for example, in India, a large class of persons, whose education is unsuitable for the employment which they eventually enter.

Of the 2,044 replies which have been received on this subject 1,186 have approved the proposal of whole-time education for selected children, whereas only 23 are in favour of part-time education for all children. Two hundred and thirty-three firms suggest a combination of the two systems. The remainder, very largely consisting of the cotton industry, approves of a combination of whole-time and part-time education, provided that both are confined to selected children. It is considered by several industries that the adoption of the system of universal part-time education will be fatal to their future development and even to their continued existence.

The first part of the Memorandum is devoted, therefore, to suggesting the outline of a scheme which, in the opinion of the Committee, might secure the following three objects: (a) The provision of an improved elementary education for all children; (b) The provision of sufficient facilities to enable a selected number of really able children of whatever class to obtain a secondary education; and (c) To enable the best of those who have obtained a secondary education to obtain a university or higher technical education.

GENERAL SCHEME OF EDUCATION.

The Committee suggest that all children should receive a compulsory education up to the age of 14, and that this age should not be extended until sufficient teachers and facilities can be provided to enable this to be done efficiently, and until the labour market has adjusted itself to the new conditions. This is almost unanimously approved by nearly 2,000 firms; in fact only six vote against it. At the age of 12 the children should be divided into two classes:

(a) *The more promising children*, who should pass either

(i.) Straight to a secondary school with the object of commencing a full course of whole-time secondary education laid out to cover a definite period of, say, 4 or 5 years, or (ii.) To a junior technical school with the object of undergoing a special full-time technical and vocational training calculated to fit them for the particular industry which their parents desire them to enter. This course should also cover a definite period of, say, 3 years.

(b) *The [illegible] children*, who should continue in the elementary school until the end of the school period in which they attain the age of 14, receiving, however, during these last two years a more general training calculated rather to develop their character, general intelligence, and powers of observation than to increase their knowledge of educational subjects. Part of this training might be directly vocational and intended to fit the child for the particular industry which it will enter at 14. This would apply more especially to towns and districts which [illegible] dependent on one industry. This subdivision is practically unanimously approved.

The secondary and junior technical courses would necessarily be voluntary. Provision should, however, be made to recompense parents to some extent for the loss of the earning power of their children, in order to encourage as many of the selected children as possible to take [illegible] complete them.

In addition to these whole-time continuation courses, the Committee [illegible] necessary to meet the conditions of some industries by providing a part-time continuation course, consisting [illegible] spent in industry. Out of [illegible] firms replying on this point [illegible] say that this system would be particularly valuable to their industry.

[illegible] carrying out a scheme [illegible] the quality of teachers [illegible] greater centralisation of [illegible] for promotion. Further, the Committee consider that the present system whereby control is [illegible]

CONCLUSION.

the result of nomination and personal influence. They have reached the same conclusion as the Committee, that a more scientific system should be set up, in which the attainments and abilities of the young persons individually may receive due consideration in their appointment to positions in industry. The Committee believe that the first essential in securing such facilities is the establishment of a suitable appointments board or similar organisation at every university and every technical school of university rank. This, however, would not in itself be sufficient, and it would be necessary to provide some central clearing house to which manufacturers could apply. This function, the Committee think, might well be filled by some such body as the Federation of British Industries.

The Committee of the Federation of British Industries, in making these recommendations, feel it necessary to add that in their opinion the importance of the subject cannot be exaggerated, nor the difference which will be made to the national welfare according as the alterations in the educational system are well or ill advised. They believe no effort or expense should be grudged in educating the future citizens of the nation, but they are convinced that it is absolutely necessary to avoid the dangers that would follow the adoption of hasty, ill-considered changes. The consequences of any change may take years to manifest themselves, and reforms should, therefore, be limited not only to the means that may be available, such as the supply of suitable teachers, but by ordinary prudence. At the present time no part of the problem requires such drastic and immediate handling as the provision of an adequate supply of teachers trained for their important work, and imbued with a sense of the high national value and responsibility of the duties entrusted to them by the nation. Although the demands on their time during the exigencies of the war have prevented the Committee making a more exhaustive report than they have done, their study of the subject has led them to the conclusion that to enlist the interest and active co-operation of employers is a national need, and they strongly recommend that the Federation of British Industries, through their local organisations, should be recognised as a body competent to be represented upon Local Education Authorities under the existing provisions of the Education Acts.

Report of Coal Conservation Sub-Committee.

In what follows we give some criticisms on this important report by Mr. Frank H. Whysall, chief engineer and manager of the Greenock Corporation Electricity Department, who writes as follows:—

I agree with the main conclusions arrived at in the Report of the Sub-Committee on Coal Conservation, but think that our criticisms might with advantage be left to a later date, when the Board of Trade Electric Supply Committee have issued their Report. It is true that many of our present generating stations ought to be supplied in bulk from other stations which show more economical generating costs. The cheapening of the supply for all purposes by more efficient methods of production and distribution is of first importance, so long as the supply does not suffer in reliability.

The establishment of a few large super-power-stations must naturally result in a great saving in fuel consumption. On the other hand, any policy of reconstruction by the Government should not be decided on without considering the national safety. An aerial bombardment of a few super-stations might cripple and possibly almost entirely bring to a stoppage a wide industrial area. There is, therefore, a good deal to say in favour of a multiplicity of moderately economical power-stations, not only from the view of safety in war time, but also on the score of reliability of supply. A considerable number of well equipped generating stations of medium capacity, adequately inter-connected, would furnish a more reliable supply than a few large stations.

With regard to the size of generating units recommended, I doubt whether the small increase in economy of the 30,000-H.P. unit over, say, the 7,000-H.P. unit would be worth striving for at the expense of continuity of supply. I recognise that the ideal site for a generating station is in the centre of a coal mining district, assuming that an abundance of condensing water is available. In America large power stations have been erected at the pit mouths, and energy is transmitted over high tension lines to the industrial districts, but there is still discussion over the commercial advantages to be gained by the transmission of energy by cables as compared with the cost of carrying coal over like distances. Losses in transmission, added to the capital charges on the lines and transforming plant, might in many cases prove, on investigation, to be greater than the freight charges on coal from the pit mouth to the industrial centres.

On the contention that private rather than public authorities would be more likely to exhibit initiative and resource in the carrying out of [illegible] the Committee favours, it is held in electrical [illegible] the [illegible] and development of municipal

enterprise in electricity supply have been greatly hampered by the restrictions and obligations laid upon them by Acts of Parliament framed many years ago with the object of protecting the interests of ratepayers. It is true, also, notwithstanding the comparisons made in the Sub-Committee's report, and in spite of the restrictions referred to, that many municipal undertakings are to-day selling electric energy at prices comparing favourably with the charges by power companies. In citing the case of the Newcastle Co. as an example of centralised production over a large area, it should be borne in mind that the supply is [illegible] from one super station, but from several generating stations feeding on the one network. Having regard to the [illegible] of our fuel resources and to the importance of reliability of supply, a properly organised scheme of linking up existing power stations [illegible] small [illegible] efficient plants would seem to be a better solution of the problem than the centralisation of power generation in comparatively few areas. Legislation could be adopted for hindering the waste of fuel at uneconomical stations, and for preventing new generating plants of comparatively small capacity from being laid down, except at positions where cheap fuel supplies and ample condensing water facilities were available. Small undertakings, both municipal and [illegible] enterprise in [illegible] supply to [illegible] would have thus opportunity of proving their capability to provide a supply as [illegible] large station [illegible] from the [illegible]

Parliamentary Intelligence.

Australian Zinc Concentrates. [illegible]

Non-Ferrous Metals Bill [illegible]

Volunteer Notices.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

[illegible]

U.S.A. Federal Census of Electrical Utilities. [illegible] "Electrical World" [illegible]

Patent Record.

SPECIFICATIONS PUBLISHED.

[illegible]

111.679.

electric machines. (31 10 16.) 111.684

netos. (27 12 15.) 102.936.

17 277 [illegible]

17 450 [illegible]

17 526 REES, E. S. G., & ARMISTEAD, W. [illegible] 111.709.

STONE & CO., J., & DARKER, A. H. [illegible] 24 17.) 111.723.

[illegible] 111.760.

[illegible] (31 7 17.) 111.812

11 579 HANMAN, J. [illegible] 111.813

13 095 WATKINSON [illegible]

APPLICATIONS FOR PATENTS

[illegible]

17 091 C[illegible]

17 095 B T[illegible]

17 111 B[illegible]

November 27, 1917.

[illegible]
[illegible]
[illegible]
17.517 DOWSING. Electric heating elements.
17525 GOMEZ. Electric telephony.
17.529 B. T.-H. CO. (G. E. Co.) Vacuum electric discharge devices.

November 28, 1917.

[illegible]
17.612 & 17.628 GRAMMONT. Electric furnaces.
[illegible]
[illegible]

November 29, 1917.

17.648 EVANS. Electric switch and dimmer.
17.655 REDFERN. Seat for tramcars, &c.
16.673 PLARSANT. Electromagnetic devices. &c.
17.674 MARINO. Spintherometers for automatically setting tools. &c.
17.675 TREDELECT ENGINEERING CO. & SMYTH. Commutators for dynamos or motors.
17 679 NEW. Electric switches.
17.689 CORNU. Mercury vapour lamps.

November 30, 1917.

17.699 ADAMSON. Electrically operated rivetting, &c., machines.
17.745 FLEMING. Electric torches.
[illegible]
17.751 B. T.-H. CO. & CLOUGH. Regulating mechanism for dynamo electric machines.
[illegible]
17.772 QUILL. Alternating current rectifiers.
17.773 HAMBURG. Automatic signalling on electric tramways, &c.
17.775 VICKERS (LTD.)—BARCLAY Dynamo electric machines.

December 1, 1917.

17.788 TURNER & WILKINSON. Electric switches.
17.801 BLOMLEY. Joints for electric welding on thin material.
[illegible] engines.
[illegible]

December 3, 1917.

17.841 STEWART. Alkaline electric accumulators.
17.849 B. PEEBLES & CO. & WEBB. Dynamo electric machines.
17.872 BERLINER. Telephone apparatus.
17.874 BOUSSON. Connecting cables or wires. (14/9/17, France.)
[illegible]

December 4, 1917.

[illegible]
[illegible]
17.923 MCQUIRE. Electrical instruments for transmission, &c., of sound.
17 930 LANGDON-DAVIES & SOAMES. Electromagnetic clutches.
17.941 HOGE. Leading in wires of electric lamps. &c.
17 942 WHITNEY. Secondary batteries. (20/9/17. U.S.)
17.945 BAIRSTO & FOWLER. Distributors for high-tension magnetos, &c.
[illegible]

December 5, 1917.

17.986 B. T.-H CO. (G. E. Co.) Electric insulators.
18.014 ETCHELLS, CONGDON & MUIR. Electric control apparatus for hydraulic cranes. &c.
[illegible] Controllers for electric motors.
[illegible]
[illegible] ELIOR. Electric interrupters. (19/1/17. France.)
[illegible] ELIOR. Ignition starting apparatus. (2/3/17. France.)
[illegible]
[illegible] ulse devices for starting purposes.

[illegible]

December 7, 1917.

[illegible]

Commercial Topics.

Tyneside Electric Power Supply.

At the meeting of the Newcastle Chamber of Commerce last week, Mr. H. W. Clothier presented a report of a sub-committee of the Chamber on the question of electric power supply in Northumberland and Durham.

The report, which had been sent to the Board of Trade, stated that 41 consumers had given evidence before the sub-committee. The evidence of these witnesses was unanimous to the effect that they were entirely satisfied with the supply of electricity for their various purposes provided by the electricity supply undertakings of the district. There were no complaints whatever to make, and the consumers were met by the supply undertakings in every possible manner. The use of electricity had enabled them to effect economies owing to the low cost of current, and the adaptability of its use, thus making further industrial development possible. The committee had noted the restrictions imposed by legislation in the past which had had the effect of retarding development and prejudicing the supply of cheap electrical energy, and was of the opinion that in any future legislation much could be gained by a study of the existing conditions in Northumberland and Durham, where the fullest advantage was taken of the resources available.

* * * *

Miners' Safety Lamps.

In the annual report of the Chief Inspector of Mines for 1916, it is stated by Dr. Wheeler that with most of the safety lamp manufacturers engaged in munition work few new types of lamps were submitted for test.

Three new types of flame lamps and three electric lamps were approved and several modifications permitted. Difficulty was still being experienced in getting British manufacturers to produce safety lamp glasses capable of passing the necessary tests and conforming with general requirements as to colour, shape and uniformity. Two different brands had been approved which compared favourably in most respects with the foreign brands.

* * * *

Priority Claims and Certificates.

A memorandum has been issued explaining the plan adopted by the Government for deciding questions of priority of manufactures and their bearing on the conduct of the war.

These questions are decided by the War Priorities Committee which was appointed some time ago by the War Cabinet. The Committee is assisted by a permanent Sub-committee composed of representatives of Admiralty, War Office, Ministry of Munitions, Air Ministry and Ministry of National Service. The War Priorities Committee performs its function of allocations largely through the medium of Allocation Sub-committees, composed of representatives of the various consuming departments concerned, and differences of opinion occurring within these Sub-committees are referred to the War Priorities Committee.

In addition, a Sub-committee has been set up which deals with works of construction, both public and private. In order that the requirements of the Public Services, such as transport, light, heat, power, &c., may receive proper consideration, a General Services Committee has been appointed by the War Priorities Committee, under the chairmanship of Mr. John Wormald, M.Inst.C.E., with representatives from the Ministry of Munitions, Admiralty, War Office, Board of Trade, and Local Government Board. This Committee considers the requirements of these services and formulates on their behalf demands which are taken into account by the War Priorities Committee in their allocation of the available supplies of the various commodities. The chairman of this Committee is assisted by an advisory committee, whose particular duty it is to inquire into the needs of the various general industries, the maintenance of which is not vital to the supply of war material or to the life of the community, but which it is desirable to preserve, if such preservation can be secured without sacrificing interests deemed essential to the [illegible] prosecution of the war. This Advisory Committee is composed of Messrs. George E. Alexander, Kenneth Chance, Alex. Walker and Henry Woodall, M.Inst.C.E., and Sir Archibald Denny, Bt., with a representative of the Board of Trade. The secretary of the War Priorities Committee is Colonel F. J. Byrne, C.M.G., 11, Pall-mall, S.W. Applications for Priority Certificates and permits should continue to be sent to the Priority Departments of the Admiralty and Ministry of Munitions.

* * * *

The National Debt and Empire Resources Development.

Mr. H. [illegible] Fox, M.P., lectured before the Royal Colonial Institute [illegible] on "The Payment of War Debt by Development of Empire Resources," and detailed some of the enterprises which [illegible] the Empire Resources Development [illegible] undertaken by the State, including the [illegible] from the [illegible] Empire [illegible] Dominion and State [illegible] United Kingdom.

[illegible]

be dangerous and impracticable. The new method must be based upon the production of new wealth under conditions which would assure to the State itself the direct receipt of a substantial share of the profits earned. That, at any rate, was the belief and gospel of the Empire Resources Development Committee.

With regard to finance, it was proposed that the precedent of the existing Development Commission of the United Kingdom might be followed, except that the Board for the Development of the Resources of the Empire which it was proposed to set up should have—what the Development Commission did not have—full executive authority in the matter of expenditure within its own sphere. It was further suggested that, in the first instance, provision for its operations might be made on the basis of £10,000,000 per annum for 10 years. It was not contemplated that the Treasury Exchequer should be the only source from which capital might be drawn. If the Statutory Authorities it was proposed to create to conduct the various enterprises in which the State would participate were organised upon a share and debenture basis in the ordinary way it would be possible and advantageous to offer such debentures, guaranteed, if necessary, by the State as to principal and interest either wholly or in part, for subscription by the poorer classes of the community. The lecturer was convinced that if that policy were followed there need be no fear that the capital required for the effective prosecution of enterprises such as those suggested would be impeded by any want of capital.

* * * *

Industrial Councils.

At the meeting of the Halifax Branch of the Workers' Educational Association last week, Mr. J. H. Whitley, M.P., explained some doubtful questions which had arisen in connection with the proposal to establish Industrial Councils.

Mr. WHITLEY said that there was some little misconception as to whether the proposals of the Whitley Report were voluntary or compulsory. They were voluntary from beginning to end; there was no question of compulsion in them. The Committee came to the conclusion that to propose anything of a compulsory nature would be to do more harm than good. The formation of the Councils must be principally the work of the industries themselves, for the success of the scheme must depend upon a general agreement among the various organisations within a given industry. The Councils would be independent bodies, electing their own officers, and free to determine their own functions and procedure with reference to the practical needs of each trade.

The report had been interpreted as meaning that the general constitution which was suggested should be applied, without modification, to each industry. That, as was pointed out by the Minister of Labour, was entirely contrary to the view of the Government. It was obvious that no rigid scheme could be applied to all industries; each industry must adopt such proposals in the report as seemed suitable to its own needs. It was made clear by Mr. Roberts, in his circular, that the representation on the Council was intended to be on the basis of existing organisations among employers and workmen in each industry, although it would be open to the Council, when formed, to grant representation to any new bodies that might come into existence and which might be entitled to representation.

It was not true, as had been suggested, that the scheme was intended to promote compulsory [illegible]. Whatever agreements may be made for [illegible] with [illegible] to the industry itself to frame, and their [illegible] would depend on the co-operation of the organisations concerned [illegible].

Another question which had been [illegible] was: Would the majority vote of one of the Councils [illegible] controlling [illegible] the wishes of either of the [illegible] of which the Council consisted, the trade unions on the one hand or the employers' organisations on the other? [illegible]

[illegible]

London Electricity Supply Loans.

During the year 1916-17 the various Metropolitan Borough Councils who own electricity supply undertakings raised 14 loans, aggregating £93,622, for extensions of plant, mains, &c., compared with 25 loans, amounting to £172,628, in 1915-16. Since 1890 the London County Council has sanctioned 525 loans to Metropolitan Borough Councils aggregating £6,781,095 for electricity supply purposes.

Electricity Supply.

Extensions.

Bath. The city electrical engineer, Mr. F. [illegible], has been instructed to inquire if it would be possible to obtain the plant required to replace the Diesel engine, if sold, in readiness for next winter's load.

Bristol. At the meeting of the Corporation last week Ald. Frank Pearson moved the adoption of a report of the Electrical Committee, recommending that application be made for sanction to purchase a 6,000 kw. turbo-alternator, four water tube boilers, together with switchgear and other accessories, for Feeder road works. Also some additions to buildings will be required, at a total cost of £76,000.

Ald. PEARSON said it would have been unnecessary for him to say much if Mr. Charles Wills, a former chairman of the Electrical Committee, had not written a letter deprecating the expenditure of such a large sum of money at present. Mr. Wills wrote as if the scheme advocated by the Coal Conservation Committee was entirely new, whereas it had been discussed for some years, and notably by their engineer, Mr. H. Faraday Proctor. The chief thing they were aiming at was to supply cheap power, and if they could give power at Avonmouth at a [illegible] per unit, they would be doing a great deal to help the development of the docks. They had plant equal to 11,540 kw., and they had in sight new demands amounting to 4,774 kw., which would bring their total consumption up to 12,359 kw., which would be in excess of their capacity. Under these circumstances, they were abundantly justified in proposing to increase their plant to 17,540kw. He had never moved a report with greater confidence.

The motion was seconded and adopted unanimously.

Colchester. The Council has decided to send a deputation to wait on the L.G. Board to urge the necessity of allowing extensions of the electric supply undertaking.

Elland. Application has been made for sanction to a loan of £2,000 for electric supply extensions.

Maidstone. The Council recently adopted the Electrical Engineer's proposals for the extension of the [illegible] generating plant, and subject to the consent of the necessary Government Departments being obtained, orders for the following plant have been given:—

Water tube boiler of 25,000 lb. evaporation, with stokers, brick work [illegible] £500; 1,500 kw. turbo-alternator, condenser, pumps, air filter and inter-[illegible]

Southend on Sea. The electrical engineer, Mr. [illegible], has been authorised to purchase from the [illegible]

[illegible]

Spenborough. [illegible]

[illegible]

Walsall. [illegible]

West Hartlepool. [illegible]

[illegible]

General.

Gainsborough. [illegible] Council will oppose the application of Mr. [illegible] Marshall for [illegible] visional order as it thinks no private monopoly [illegible] electricity supply should be created in the district.

Increased Charges for Electrical Energy.—The charges for current [illegible] are being increased :

[illegible] 25 per [illegible]

[illegible]

Power Co. for current supplied to the Borough of Dudley is to be in- [illegible]

At West Ham the following rates have been adopted :—For lighting, a [illegible] ; 3d. per unit for 10 per cent. of power consumption and remainder at $1\frac{3}{4}$d. ; [illegible] and maintenance, with minimum payment per hour, $3\frac{1}{2}$d. A minimum [illegible]

At Colne a flat rate only of $5\frac{1}{4}$d. has been adopted for lighting (in- [illegible] per unit.

At Beckenham the charge for lighting has been increased to 8d. per unit and power and heating charges by $\frac{1}{2}$d. per unit.

East Ham Council has increased its charges to private consumers and [illegible] 33 per cent. over pre-war. The charge for current for tramways is increased 10 per cent. (total 20 per cent.).

[illegible] has increased its charges [illegible] For lighting in private residences the charge is to be 6d. per unit.

At Blackburn the charges for light, heat and power are increased a further 10 per cent., the pre-war rental of meters is increased 20 per cent., [illegible] 2s. 6d. per meter per quarter is [illegible]

[illegible] charges for current by a further 10 per cent. (total 20 per cent.).

Provisional Order Transfers. [illegible] Board of Trade has extended [illegible] for making the transfers [illegible] Bradford-on-Avon Electric [illegible]

Rochdale. [illegible] was stated that [illegible] to annul a contract for electricity supply entered into with the Corporation before [illegible]

St. Annes-on-Sea. [illegible] Urban Council, Mr. [illegible] works was taxed to its [illegible]

Stepney (London). [illegible]

Stoke Newington (London). [illegible]

Worcester. [illegible]

Electric Traction.

Birmingham. [illegible]

and thus reduce the number of horses and mechanically driven vehicles in the city.

Mr. Neville Chamberlain stated that tramways laid in macadam roads were doomed and that there would be an enormous development of sleeper track tramways, which were in reality light railways, for passenger and goods traffic.

Glasgow. At the meeting of the Corporation last week the Chairman of the Tramways Committee (Mr. Montgomery) stated in reply to a question, that the tramway track was not in quite such order as it was before the war, because there was such a scarcity of labour and materials.

Before the war a staff of 800 men were employed on the work of keeping the track in condition, but there were now 500 constantly employed on day and night shifts. The track might be "jolty" in parts, but no effort was spared to keep the track in as good order as possible.

Goods Traffic on Tramways.—An article in the "Daily Express" of the 10th inst. advocates the use of the tramways for the transport of food and other goods.

It is suggested that the growing difficulties of the transport of food and other goods, due to the shortage of petrol, horses and labour, might be lessened, if not wholly removed, by utilising more fully the existing tramway routes. The tramways were laid down mainly for the conveyance of industrial workers, and in nearly all cases the tramway routes pass close to railway stations and industrial works. Branch lines from existing main lines might be laid down, running into large industrial works and railway goods stations. These lines would not require to be more than 50 to 100 yards in length, and along part of each branch would be a transit shed with suitable platforms for loading and unloading. The coaches would be loaded up during the day, and when the ordinary tramway traffic ceased (between midnight and 4 a.m.) the coaches could be driven to their destinations—viz., goods stations or other industrial works. After dealing with the advantages of and objections to the proposals, it is pointed out that in many places, such as Margate, Ramsgate, Lowestoft, &c., which are at present running their tramways at a loss, some of the lines could be taken up and utilised for the branch lines suggested. A number of passenger tramcars, which at present are not being utilised to their fullest capacity, could be converted into goods carriers at an appreciably low cost. The taking up and laying down of the tramway lines could be performed by German prisoners, with a proportion of skilled men as supervisors.

London United Tramways. The directors of the London United Tramways (Ltd.) have signed an agreement with the London County Council settling all matters of difference with reference to the purchase by the London County Council of the company's tramways in Hammersmith.

The Council will pay to the company £235,000 in satisfaction of all the items included in the arbitrator's award of Feb. 12, 1912, which until the date of the agreement, has been the subject of litigation. Included in the purchase money is the Chiswick power station and depot of the company. The Council further agree to pay forthwith £12,000 towards the costs incurred by the company. The purchase money is to be paid on or before the expiration of one year from the determination of the present war, but until the purchase money is paid the company are to remain in possession of the purchased tramways and to take the traffic receipts. From and after the completion of the purchase the Council and the company are to have reciprocal running powers over the lines of the other, and the present arrangement between the company and the railway companies for through bookings at Shepherd's Bush and Hammersmith are to be continued by the company until the completion of the purchase.

Southend. The L.G. Board have refused to sanction a loan of £4,150 for the purchase of electric vehicles, but efforts are to be made to induce the Board to reconsider the matter.

Southport. On Tuesday the Corporation decided to purchase the undertaking of the Southport & Birkdale Tramways Co. for £50,000 as from the 1st inst.

The company will make a payment of £1,200 to the Corporation on [illegible] account, and will defer payment of the purchase money until July, 1922, or earlier at the Corporation's option, in order to get over the difficulty of raising a loan during the war.

Tramway Workers' Wages. The men and women engaged as drivers and conductors on the tramways throughout the country have [illegible] demand for an increase of war wages, amounting to £1 per week on pre-war rates. The matter has been referred to the Committee on Production.

York. The Council recently resolved that it viewed with great concern the appointment by the Board of Trade of a committee with [illegible] in connection with the supply of materials and labour for tramway undertakings.

[illegible] that the committee, if it is necessary to continue, should be reconstituted on the basis of containing representation of the [illegible] private interests concerned proportionate to their magnitude [illegible] that the chairman of such committee should be [illegible] connection with any traffic undertaking likely to [illegible] committee should be [illegible] interest in connection with any Government [illegible]

Imperial Notes.

Australasia. The Brisbane Electric Tramways Investment Co. has been informed by cable that Bills recently introduced in the Queensland Legislature (1) provide for a drastic reduction of fares on the Brisbane tramways, which will restrict the company's profits to 5 per cent. on the value of the tramways; and (2) authorise the purchase of the undertaking by the Government.

[illegible]

[illegible] six months later the authority would take over the assets, &c., of the [illegible] the Melbourne, Brunswick, Coburg, Fitzroy, Northcote, Preston, [illegible] Ministry had virtually adopted the recommendations of the Commission. [illegible] board appointed by the Governor in Council would hold office for five years, and be eligible for re-appointment. The salary of the chairman [illegible] of Parliament or of any municipal council. The other Members would be elected for three years. They would each receive £100 a year.

There would be replacement reserve and general reserve funds. [illegible] would be carried to it every year. To the general reserve would be carried not less than 1 per cent. of the capital cost, and out of this fund might be provided part or the whole of any deficit in any year, and any sum spent upon new or special works. The authority could borrow up to £750,000, exclusive of any principal sums the liability for which was transferred to it from existing authorities.

[illegible] a council's undertaking by agreement, and a private undertaking either [illegible]

Malta. [illegible]

New Wolfram Companies in Burma. [illegible]

Miscellaneous.

B. E. A. M. A. Publications. [illegible]

"Board of Trade Journal." [illegible]

Customs Decisions.—According to a recent decision of the New Zealand Customs Dept. the duty upon brake blocks or shoes (claimed as parts peculiar to air-pressure brakes for tramcars) is 30 per cent. ad val. on foreign goods and 20 per cent. on British goods.

[illegible] electric motor tyre pumps, electro-magnets (part of crane), Harris patent feed water filters, and patent quarzarc electrodes.

Electrical Trades Benevolent Institution.—As a result of the recent [illegible] nearly £200.

Amongst the amounts received are the following: Sir David Salamons £20, Vickers (Ltd.) £21, Mr. John P. Hooper £10. 10s., Messrs. Heilbut, Symans & Co. £10, Aldens Successors (Ltd.) £10 and Callender's Cable [illegible] £21.

Enemy Firm Wound Up. [illegible] Co. (Ltd.) are to be sent to the Controller, Mr. John Paterson, 1, Walbrook, London, E.C., by Feb. 1.

[illegible] Farringdon-road, London, E.C., has applied for a release. Objections to [illegible]

Engineer as Novelist.—Mr. Tomy Thompson, the author of the [illegible] the fortunate position of being able to combine literary imaginative effort with practical technicalities. He is better known to the industrial community as the Swansea district engineer for the British [illegible]

Naval Wireless Telegraphists' Pay. It is announced in the [illegible] sub-lieutenants and officers of higher rank in the Royal Naval Air Service, who are qualified in wireless telegraphy, are entitled to 3s. a day skill pay, in addition to their flying pay, and warrant [illegible] to 1s. a day skill pay, in addition to their flying pay.

Raw Asbestos. [illegible] Act states that no person or company shall sell, supply, or deliver [illegible] or purchase or negotiate or take delivery of any raw asbestos, &c., [illegible] will be required to make returns.

Presentation.—On the evening of the 10th inst. there was a big [illegible] electricity works). [illegible]

[illegible] establishment. The presentation which he had the pleasure of handing Mr. Proctor (a silver epergne and a silver cake tray) was a slight token of their loyalty and esteem, and an assurance of their continued loyalty and co-operation.

Mr. PROCTOR said he really could not find words in which to express his thanks to those who had arranged the social evening and for the beautiful articles they had presented him with. He was very grateful to all who had come to mark his twenty-fifth year of service with the Bristol Corporation. He regretted very much the absence of those serving their country, and those on shift duty for the department, and he would have liked them to have been present. He wished those serving their country a speedy and victorious return to the department. He would like to mention that the day was not very far distant when another site would have to be found for the main generating station, as the water in the Feeder canal and River Avon would be far too little for ultimate developments. If the recommendations of the Coal Conservation Sub-committee were adopted, it would be just possible that a large station would be erected on the banks of the Severn, where one might obtain the perfume of roses, which Mr. Stapleton longed for, but hopes in that respect were slender, as chemical and high explosive, together with spelter works, were being contemplated.

He would like to say one or two things about themselves. The Lord Mayor of Bristol in several speeches he had recently made commented on the labour unrest and advocated that the heads of all business establishments should take their staff and employees to their hearts. In the early days of the undertaking it was a very great pleasure to him to know every employee by name and something about him, but the increasing growth of the department had prevented that in the latter years. It was a matter of great regret to him that he could not come into contact with them more often. He was very glad to say that no serious trouble had ever arisen with any portion of the staff or employees, and he thought that was a fact to be justly proud of. There was no reason why there should be. The Corporation had a duty to fulfil in seeing that the conditions under which their employees worked were satisfactory. Generally speaking, he has always had most loyal support from his staff. He thanked them most sincerely for their magnificent gifts, which would be handed on, and for which his wife and family would be as equally proud of as himself.

Trading With the Enemy. The "London Gazette" of Jan. 11 contains additions to the list of firms and persons with whom trading by firms and persons in the United Kingdom is prohibited.

These include the following: *Mexico*: Allgemeine Electricitats [illegible] (Mexico City), La Electrical (Mexico City), Electromotors S.A. (Mexico City), Orenstein & Koppel's Arthur Koppel S.A. (Mexico City), [illegible] & [illegible] (Mexico City).

Educational.

University College, University of London.—A course of three lectures on "The Principles of Fuel Economy in the Design and Use of Cooking Appliances" will be delivered by Mr. A. H. Barker, B.A., B.Sc., on Jan. 23 and 30 and Feb. 6 at 7 p.m. The lectures are open to the public without fee or ticket. Further particulars may be obtained from the Secretary, University College, London (Gower street, W.C. 1).

Education Bill. In the House of Commons on Monday Mr. H. Fisher introduced the Education (No. 2) Bill.

The new measure is substantially the same as that introduced in [illegible] have been amended, and [illegible] the clauses relating to attendance [illegible].

Royal Technical College (Glasgow).—The reports presented at the [illegible] 2,587, including 153 day [illegible] over the previous year [illegible] and 1,342 evening [illegible] 1916-17.

[illegible]

Tenders Invited and Accepted.

Telephone Material.

Tenders are invited by Feb. 27 for supply and delivery to the Postmaster-General's Department of South Australia of Telephone Material as per schedules 479 and 483. Specifications, &c., from the Commonwealth Offices, Australia House, Strand, London, W.C. 2. *See advertisement.*

The Deputy Postmaster-General, Sydney (N.S.W.) requires tenders by 2.30 p.m. Jan. 28 for the supply of telephone and switchboard parts (Schedule 643 N.S.W.) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specification from the Deputy Postmaster-General.

Electric Crane.

MANCHESTER Waterworks Committee require tenders by Feb. 2 for the supply of an electrically driven Radial Arm Crane. Specification, &c., from the Secretary of the Waterworks Dept., Town Hall, Manchester.

Fan Motors.

MANCHESTER Electricity Committee require tenders by 10 a.m. Jan. 19 for supply and erection of three-phase Motors for cooling tower fans at Stuart-street generating station. Specifications, &c., from Mr. F. E. Hughes, Town Hall, Manchester.

Electrical and General Stores.

TOXTETH PARK Guardians require tenders by noon Jan. 27 for three months' Electrical and Engineers' Supplies, Ironmongery, Oils, &c. Forms of tender from the Clerk, 15, High Park-street, Liverpool.

Telephone Service.

ROSARIO (Argentina) Municipality recently invited tenders, which are to be opened on Feb. 23, for the provision of a telephonic service within the district of the municipality.

HALIFAX.—The Corporation have accepted the tender of the British Electric Transformer Co. for the supply of a transformer, at £577; and that of H. Morris (Ltd.) for a crane, at £59.

HULL.—The Corporation have placed an order with the British Westinghouse Co. for the supply of extra high-tension switchgear, at £1,284.

METROPOLITAN ASYLUMS BOARD.—The contract for the maintenance of the storage batteries of electric vehicles at Queen Mary's Hospital has been given to the Tudor Accumulator Co.

WALSALL.—The Council has renewed the contract with Callender's Cable Co. for the supply of rubber-covered cable.

WOLVERHAMPTON.—The Town Council has accepted the following tenders: General Electric Co., converter plant, £2,792; Brush Electrical Engineering Co., two 300 k.v.a. oil cooling transformers, £326.

MELBOURNE (VICTORIA).—The Corporation have accepted the tender of the Australian General Electric Co. for the supply of 1,000 500 watt gas filled metallic filament lamps, at £850; Sutherland & Ashman, for two three phase 100 k.v.a. transformers, £299; and that of R. Bryce & Co., for 200 lanterns for gas filled lamps, at £668.

Appointments Vacant and Filled.

Applications are invited for the position of junior shift engineer at the new temporary station (Nechells) of the Birmingham Electric Supply Department. Commencing salary £150, rising to £200 per annum, plus £23 extra during the war. Applications to the city electrical engineer, Mr. R. A. Chattock, 14, Dale End, Birmingham, by Jan. 19. *See advertisement.*

A [illegible] constructional engineer is wanted to take charge of the erection of a [illegible] power station. Applications to Director of Electric Power Supply, Ministry of Munitions, 8, Northumberland avenue, London, W.C. [illegible] *See advertisement.*

[illegible] lecturer in electricity is required at the Merchant Venturers' Technical College, Bristol. Salary £250 per annum. [illegible] form of application from the Registrar. [illegible]

[illegible]

Applications are invited for the post of head of the electrical engineering department of the Loughborough Technical Institute. Salary, £220 per annum with £30 war bonus. Applications by Jan. 19.

Applications are invited for the post of Head of the Department of electrical engineering and physics of the Victoria Jubilee Technical Institute, Bombay. Salary Rs. 700. Applications by March 31, 1918, to Mr. D. E. Wacha, Honorary Secretary of Board of Trustees, Byculla, Bombay, India.

Wolverhampton Council has appointed Mr. Chas. Wm. Charlesworth, of Stoke-on-Trent, commercial secretary to the electricity undertaking, at £300 per annum.

Mr. G. F. Barnes, of Hayle, and Mr. G. [illegible], of Huddersfield, have been appointed charge engineers at Worcester at 55s. a week, each plus 10s. war bonus.

Business Items.

Mr. Arthur Willmott, A.M.I.E.E., has resigned his position (after 11 years) as works manager of the Electric & Ordnance Accessories Co. (Vickers, Ltd.), of Birmingham, and is taking up the post of general manager with Messrs. A. A. Lyon & Wrench, [illegible]-road, Willesden.

Plant Wanted. Messrs. Kryn & Lahy Metal Works, Ltd., Letchworth, Herts., advertise for a d.c. electric motor of about 200 h.p., 500 volts.

Prescot Fuse Boxes. The British Insulated & Helsby Cables (Ltd.), of Prescot, have recently issued leaflet No. P. 149, which gives particulars of the Prescot fuse boxes.

These fuse boxes are of the non-sealing type for single cables, and are fitted with porcelain bridge fuses. They are designed to meet the Home Office requirements. All live metal parts are so protected that they cannot be inadvertently touched, and the design of the fuse handle and base renders impossible the scattering of metal when the fuses operate.

Bankruptcies, Liquidations, &c.

An application for the discharge of Geo. Edwd. Hipkins, electrical engineer, 48, Wolverhampton-street, Dudley, will be heard on Feb. 5 at the Court House, Priory-street, Dudley.

The Brazilian Street Railways Co. (Ltd.) is being wound up voluntarily, and Mr. H. Tattam, River Plate House, 10 and 11, Finsbury-circus, London, E.C. 2, has been appointed liquidator. Claims to Mr. Tattam by Feb. 28.

A receiving order has been made against Wm. [illegible] Smith, electrical and mechanical engineer, Victoria-street and Hampden-street, Bolton.

Winding Up Petition. A petition for the winding up of the Rotherham Electrical Engineering Co. (Ltd.) will be heard at the County Court Hall, Sheffield, on [illegible] 24.

Deed of Assignment.—Claims against Basil Chas. Cousens, electrical engineer, Wyre Dock and [illegible], Fleetwood, under a deed of assignment executed by [illegible] 28 last, are to be sent to Mr. Jas. Todd, 18, Birley-street, Blackpool, by Jan. 24.

Municipal Accounts.

Birkenhead. [illegible]

Exeter. [illegible]

Finchley.—The report of the electrical engineer (Mr. E. Calvert) on the working of the Council's electricity undertaking for the year ended March 31 states that capital expenditure amounts to £140,820 (increase £2,340), of which £56,160 has been repaid or provided for repayment.

Income was £28,912 (against £24,150 [illegible]) and gross profit was £10,690 (£10,732). Interest [illegible] £3,414 and repayment of loans £6,000, and net profit, [illegible] sundry charges, including bank interest, was £516.

On Feb. 24 there was a brief stoppage [illegible] the destruction of an isolating street [illegible] re-instatement of the supply was due [illegible] other occasions faults have been [illegible] averted by its aid. New consumers [illegible] tions were 526. The total connections are equivalent to 150,632 8 c.p. lamps. Units generated were 2,800,000 (compared with 2,046,000 in previous year) and sold 2,379,428 (1,695,857). Working and general expenses were 1·714d. (1·706d.) per unit sold. [illegible] 23 (18·65) per cent. and maximum load 1,178 kw. (1,037 [illegible]) [illegible] 26s. 5d. (compared with 24s. 6d.) per ton, and fuel oil cost £8. 12s. 9d. (£3. 12s. 3d.) per ton, and these two items [illegible] £2,950. The plant is equal to a maximum load of about 1,000 kw. and the maximum load already reached is 1,187 kw. [illegible] may be estimated at 1,400 kw. for the winter of 1917-18. Mr. Calvert thinks a suitable solution of the problem [illegible] neighbouring undertaking.

Greenock.—The accounts of the electricity department for the year ended June last show gross capital expenditure £404,841, of which £96,856 has been repaid, while the reserve fund amounts to £41,200.

Revenue was £96,843 (compared with £85,649 [illegible]) working expenses were £54,781 (£52,612), the gross [illegible] £42,062 (£33,037). Interest and special expenditure required £13,289 (£10,160), and sinking fund and depreciation £17,941 ([illegible]), leaving a net balance of £10,831 (£6,998). Fuel cost 0·363d. (0·373d.) per unit sold, and total costs, exclusive of capital charges, [illegible]. Units generated were 25,576,509 (23,235,816), and sold 21,149,458 (19,001,464). Total maximum demand was 7,783 (7,480) kw., and load factor 31·02 (28·99) per cent. Consumers increased from 1,889 to 2,049.

Mr. F. H. Whysall, chief engineer and manager, says in his report the Coal Controller has now advised that electricity be used [illegible] in the household, to reduce the transport of coal for domestic purposes. It is intended therefore to continue the [illegible], &c. The department during the year [illegible] totalling 593 kw., and altogether [illegible] 466 kw. The capital on these [illegible] £9,785 has been written off. The [illegible] £1,765 for the year.

Stepney (London).—The accounts of the electricity department for the year ended March 31 show gross capital expenditure £674,281 (increase £29,240), of which [illegible].

Income was £134,867 (compared with £104,531 [illegible]) working and general expenses and special [illegible] £94,710 (£69,289), leaving gross profit £40,156 (£35,242), and the net result, after providing for interest and repayment of loans [illegible] £3,184 (£5,861). [illegible] per unit sold, and [illegible]. Average [illegible]. Units generated were 29,151,411 (27,827,[illegible]) [illegible] (2,556,946) and sold 27,011,530 (24,971,891). Total connections are [illegible].

[illegible]

New Companies, Mortgages and Charges, &c.

New Companies.

ADAMS BROS. (LONGTON) (LTD.) (149,322.)—Private company. Reg. [illegible] capital £1,000 in £1 shares. To take over the business of [illegible] merchants, manufacturers of and dealers in electric, [illegible] telephone and other appliances formerly carried on as Adams Brothers, at Longton.

EDWARD LUCAS & SON (LTD.) (149,355.)—Private company. Reg. Dec. 10. Capital £25,000 in £1 shares. To enter into an agreement with T. H. Lucas and to carry on the business of ironfounders, mechanical and electrical engineers, &c. First directors are T. H. Lucas (permanent governing director), R. W. Lucas and J. W. Lucas, Dronfield.

GENERAL ENGINEERING CO. (LTD.) (149,197.)—Private company. Reg. Dec. 31. Capital £500 in £1 shares. Electrical, mechanical [illegible] engineers, manufacturers, &c. First directors are R. Duxbury (managing director), B. Davy and J. Fielding (chairman).

NORTHUMBRIA MOTORS (LTD.) (149,301.)—Private company. Reg. Dec. 21. Capital £2,000 in £1 shares. Electrical, mechanical [illegible] manufacturers of dynamos, engines, rheostats and electrical apparatus, dealers in motor [illegible]

NORWOOD ENGINEERING CO. (LTD.) (149,293).—Private company. Reg. Dec. 2, 1917. Capital £20,000 in £1 shares. To adopt an agreement [illegible] mechanical and electrical engineers, manufacturers of agricultural implements, &c. A. de Angelis (French) and A. H. Whitner (British) are first directors.

RAILLESS LTD [illegible] Private company. Reg. Jan. 7. [illegible] agreement with B. D. Fox, [illegible] E. M. Munro [illegible] manufacture and contract for the supply, delivery and carriage of, and to erect, maintain, repair and work material, machinery, permanent way, rolling stock, &c. First directors are B. D. Fox, A. Hoare, E. M. Munro. Reg. office, 272, Finsbury-[illegible]

Mortgages and Charges.

RUSHMORES LTD [illegible] of £30,000 debentures created Dec. [illegible] 1917, [illegible] whole amount being now issued. Property charged, company's undertaking and property, present and future. No [illegible]

City Notes.

DIRECT UNITED STATES CABLE CO. (LTD.)—The directors have declared an interim dividend of 2s. per share (less tax), being at rate of [illegible] for the quarter ended Dec. 31 last.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.) [illegible] debenture stock register will be closed from [illegible]

ELECTRICAL UTILITIES CORPN. (LTD.)—Dividend of 1¼ per cent. has [illegible] quarter ended Dec. 31.

GENERAL ELECTRIC CO. (LTD.)—In addition to the half-yearly divi[illegible] preference shares, an additional [illegible] tax free, representing the [illegible] 1916 [illegible] 1917.

KAMINISTIQUIA POWER CO. (LTD.)—The directors have declared a [illegible] per cent. per annum, on the [illegible] revenue for the [illegible] operation and maintenance [illegible] \$31,000, net [illegible] \$191,151 [illegible] \$153,720, [illegible] surplus account [illegible]

LIVERPOOL OVERHEAD RAILWAY CO [illegible]

SOUTHERN BRAZIL ELECTRIC CO. LTD [illegible]

STOCK EXCHANGE NOTICE [illegible]

The Round Table.

By "kVA."

"Booster" Highfield, who presided at the Electro Harmon[ic] Concert on Friday last, was so pleased with the item in th[e] Unofficial Programme, "We feel VERY Hackneyed now" b[y] the Gas Light & Coke Co., that he announced it from the cha[ir] as one of the turns of the evening!

* * * *

I have received an anonymous communication from [a] "Round Table" Reader suggesting an item which should hav[e] appeared in last week's Unofficial Programme. If this reade[r] will kindly forward his name and address I will publish th[e] item, anonymously, of course.

* * * *

Owing to the inclusion of the Unofficial Programme in th[e] "Round Table" last week I had to hold over the concludin[g] verses of Mr. Barnard's poem on Dora.

D.O.R.A. THE DESPOT.

(SHE WHO *MUST* BE OBEYED.)

(Concluded from page 546.)

You go for the night to the nearest hotel;
She asks for your name and your number as well;
And if she suspects you of "telling the tale,"
Why, Dora the Despot will clap you in goal.

You climb to your room at the top of the house;
It's stuffy and dark, so you fumble and grouse;
But don't touch the window, or soon you will find
That Dora will nab you for moving the blind!

Next morning, perhaps, you go out for a walk
And join with a native in innocent talk;
But Dora's been watching, and wants to know "Why?"
And if you can't tell her you're shot for a spy.

You turn in despair to go home to your wife,
But Dora's no love for the family life.
She's looking for slackers, and asks you to show,
Since *you're* not in khaki, why *are* not you so?

Oh, Dora's a lady who won't be gainsaid!
She's here for your good, and she must be obeyed;
And if you don't like it you'd better keep mum—
For Dora's on top, and you're under her thumb.

She's somebody's darling—I do not know whose—
But Dora's a blessing I'm willing to lose;
And when the war's over, and joy-bells are rung,
I shan't be downhearted if Dora gets hung!

A. S. B. in *The Chloride Chronicle*

* * * *

Apropos of the above, I am assured on good authority tha[t] every Government Department comprises two sections: ( ) The Hope the War will never-be-over Department, and ( ) The Department for the Invention of Work.

* * * *

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, Jan. 15, 1881.]

GREENOCK.—The Harbour Trust has invited the various electr[ic] light companies to give a display of their apparatus on the steambo[at] [illegible] with the view to a permanent use of one system.

ST. SAVIOUR'S GUARDIANS.—At the last meeting of the Guardian[s] a letter was received from the Brush Electric Light Corpn., statin[g] that the company had contracted with the Commissioner of Sewe[rs] for the lighting, by means of electricity, of Blackfriars Bridge, Ne[w] Bridge-street, Ludgate-circus, Ludgate-hill, and other parts of th[e] City, and were desirous of being allowed to lay down the necessar[y] [illegible] in a three-inch pipe underground, for the conveyance of th[e] electricity from their works in Vine-street, Lambeth, via Stamfor[d-street] to Blackfriars Bridge. The chairman thought the communi[cation] [illegible] had better go to the Paving Committee, and suggeste[d] whether the board could not try the experiment of the electric ligh[t] [illegible] at the top of the Southwark-street. Mr. Staffor[d] would like to see the whole of Southwark-street lighted with th[e] [electric] light. He moved the reference of the letter to the Pavin[g] Committee. Mr. [illegible] seconded the resolution, which was carrie[d].

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CONTENTS.

Notes.

Reorganisation of the Board of Trade.

SOME details have now been published, and will be found in another column, of the re-organisation of the Board of Trade. This re-organisation has been the result of consultation with an informal committee, and is independent of the Joint Department of Overseas Trade recently set up by the Board of Trade and the Foreign Office. The work of the Board of Trade is now to be organised under two main departments, consisting, on the one hand, of the Department of Commerce and Industry, and, on the other, of the Department of Public Services Administration. The first of these Departments is of the greater importance, as its successful working and vitality will largely depend upon the initiative of those concerned. It is proposed to set up a number of sections. One of these will deal with the work of the trade commissioners, commercial attachés and of the consular services, which work forms a part of the duties of the Joint Department.

Our Home Industries and the Board of Trade

[illegible] ment will be charged with the encouragement of invention, and the protection of the [illegible] from the abuse of monopoly. We notice that questions of policy relating to industrial power, including electricity, will be handled by one of the sections, and that another section is to be created to deal with economic policy, and will take over the duties of the temporary Industrial (War Inquiries) Branch of the Board of Trade. A strong advisory council is to be attached to the Department of Commerce and Industry, thoroughly representative of the commercial and manufacturing interests of the country. Turning to the Public Services Administration Department we find that this department will deal with many of the matters already handled by the Board of Trade, including the Electric Lighting Acts. It appears, therefore, that the electrical industry will still have to deal with more than one Government department. From what we have said it will be gathered that a comprehensive programme has been arranged, and we trust that it will be administered in such a way as to be of real benefit to the industries of the country.

A Constant Torque Electric Clutch.

IN comparison with the ordinary mechanical clutch there is something fascinating in the electromagnetic clutch, which is so much simpler in its control. Nevertheless, in putting the idea into practice considerable difficulties are found. The ideal is, naturally, to have a clutch in which the pressure exerted between the two parts, and thus the torque produced, is related quite simply to the exciting current, so that a small variation in this current is sufficient to cause slipping, or to transform the clutch into one in which the two parts are rigidly coupled together. Unfortunately, any such idea is entirely upset by the hysteresis of the iron. The magnetic attraction with a decreasing current is by no means the same as that with an increasing current, and, what is still more important, when the exciting current is reduced to zero the residual [illegible] that the clutch may still continue to drive. If it is sought to overcome this difficulty by [illegible] introduces the objectional feature that the clutch comes in [illegible] "fierce clutch," which produces discomfort in the running of automobiles. Magnetic difficulties, however, are not the only difficulties that are to be found. As is well known, slipping [illegible] tained by varying the excitation [illegible] at all [illegible]

evident by the generation of a constant current under the severe conditions of electric welding without resistance in the arc circuit. The current remained practically constant, even on short-circuits.

Ten Years of Illuminating Engineering.

IN his Paper before the Illuminating Engineering Society on January 15th Mr. L. GASTER reviewed the progress of the Illuminating Engineering Society in this country since its formation was suggested about 10 years ago. The Paper forms a useful supplement to Mr. TROTTER'S presidential address, to which we referred recently, and gives a good idea of the wide ground covered by the Society's work, and the difficulties which it has successfully overcome. Few of those present at the inaugural meeting in 1909 could have anticipated the conditions prevailing now. But the Society has adapted itself to the restrictions imposed by the war, and has shown considerable perseverance and determination in finding new fields of activity. Mr. GASTER referred to a problem which has exercised the minds of members of all the chief scientific and technical societies since the outbreak of war—namely, that of inducing Government Departments to make proper use of their services. In the absence of organised channels of communication most engineers and scientists have had to be content with offering their services whenever an opening appeared, sometimes with disappointing results; it is much to be hoped that one result of the war will be a more carefully prepared plan by which any problem on which guidance is desired can be immediately brought to the notice of the society concerned. Naval and military operations, carried on alike by day and by night, are essentially dependent on vision, and there must be many special problems on which technical knowledge of illumination would be helpful. After the war many equally important fields for service in connection with reconstruction will doubtless arise.

Data on Illumination.

THE latter part of the Paper was devoted to a discussion of methods of acquiring statistical evidence on many essential points, on which there is common agreement, but insufficient data in support of the accepted view. Among such points are mentioned the relation of illumination to accidents in factories and streets, and to output and quality of work. In the present circumstances one appreciates the difficulty in making such inquiries, owing to shortage of staff, &c., and yet in many respects the conditions are such as to make these investigations fruitful. For example, the street lighting conditions are such as [illegible], while the organisation of industrial operations by the State makes it easier than in normal times to obtain data on a uniform basis. Painstaking investigations of this kind are rarely appreciated at their proper value. They call for great patience and devotion and have not the glamour that surrounds great inventions; yet their influence on humanity may be equally far-reaching, and their results of very great importance.

Interlinking in the West of Scotland.

Some time ago we published further details in regard to the proposed interlinking of electricity supply undertakings in the West of Scotland. Fortunately in this part of the country the position is less complicated than in many other districts, the frequency being generally 25 periods, the exception being [illegible] periods in the Glasgow and Clyde Valley district. A number of load curves accompanying the report of the Committee, [illegible] for the half [illegible], the work of the Committee has been [illegible]. It is impossible for us to reproduce all these curves, but we give those relating to the Glasgow Corporation Electricity Department, the Glasgow Corporation Tramways Department, and the Clyde Valley Electric Power Co., and a composite curve for the whole of the undertakings. It is noticeable that the curves in this case are by no means as ideal as could be desired. In other words the peak load is very pronounced, from which it may be inferred that the lighting load in the Glasgow and Clyde Valley district is still a prominent part of the whole. On the other hand, if some of the other districts are taken it is noticeable that the load curves obtained are considerably more satisfactory. This scheme has for its primary object the interlinking of undertakings for week-end supplies, and certain economies are thus rendered possible. This step, however, is by no means sufficient to gain the greatest economy, and this is evidently felt by the Committee, for it is remarked in the report that although the economy of week-end supplies in some cases may be doubtful, considerable economy could be effected in many cases by a supply in bulk from the larger to the smaller stations. Certainly it is only in this way that such figures as 4·3 lb. and 5·4 lb. of coal per unit generated, which figures we notice are given for two of the groups, can be eliminated.

Scottish Municipal Electrical Association.—This association has been formed for the purpose of safeguarding the interests of the smaller municipal electricity undertakings Councillor D. M'Callum, convener of the Greenock Corporation Electricity Committee, has been appointed chairman, and Mr. William C. Bexon, burgh electrical engineer and tramways manager of Kilmarnock, as secretary.

Metallurgical Research in Scotland.—At a meeting of Scottish employers and others in Glasgow on Tuesday afternoon it was unanimously agreed to form a Scottish Engineering, Shipbuilding and Metallurgical Research Association. A draft memorandum of the constitution was submitted and approved. Sir Donald MacAlister, principal of Glasgow University, who spoke in support of the scheme, emphasised the importance of research.

Association of Mining Electrical Engineers.—At a joint meeting of the West of Scotland Branch of the Association of Mining Electrical Engineers and the National Association of Colliery Managers a Paper was read recently by Mr. J. H. C. Brooking on "Cable Complaints." The author laid stress upon the necessity for frequent testing and on the undesirability of laying bitumen cables in the ground, especially if the soil contained corrosive compounds.

Board of Trade Journal.—Five issues have now appeared of the Board of Trade "Journal" in its new form. We hope that a marked feature will be made of the "special articles," as a great deal of useful information can be so given; and if an official journal could be made to appear less depressing it might be an advantage. We are glad to note that advertisements are to disappear from the pages of the "Journal" shortly. This is a most desirable change in Government publications.

Engineering Opportunities in Serbia.—On January 21st Sir Wilfrid Stokes presided at a luncheon given by the Council of the British Engineers' Association to the members of the Serbian Industrial Commission who are on a visit to this country. The Serbian Minister, Dr. Djuric, Mr. D. Tomich and others referred to the important part to be played by engineering in the reconstruction of Serbia, in which, it was hoped, British engineers would take a prominent part. Serbia required machinery, tools, locomotives, electrical apparatus, &c., in order to develop her valuable products, and she looked to Great Britain for her supplies after the war. Some 300 young Serbians were completing their education in this country, and it was hoped that more would be sent over to be trained as engineers.

The Oil Engine as a Prime Mover.—An article by W. L. H. Doyle in the "Electrical World" describes some interesting results obtained from a small oil-driven electrical plant converted from a pair of slow-running Corliss engines operating a long line of shafting. The generator capacity was only 64 H.P. k.w., the engine being run on a guaranteed consumption of half a pound per brake-horse-power of any sort of crude or fuel oil having a thermal value of 1,800 B.Th.U. per pound. The results for the year 1916 show a load factor of 59 per cent., which was fairly constant. The cost per kilowatt-hour amounted to 2·11 cents (approximately 1d.), nearly half of which consisted of overhead charges, the oil forming only a quarter of the total. This is considered remarkable in so small a plant, and in view of the present cost of coal, fuel oil is likely to play an important rôle in power production in districts in the United States where conditions are reasonably favourable.

Institute of Chemistry.—Part III. of the "Proceedings" of the Institute of Chemistry for 1917 (July-November) refers to a number of points of interest, including the continued development of special researches on glass. We notice two varieties specially adapted for holding tungsten wires, one of which is considered useful for certain forms of electric lamps. Correspondence with the Department of Scientific and Industrial Research refers to prospective researches on laboratory and optical glass, cements for lenses, &c., on which a new committee is in contemplation. A sub-committee of the Glass Committee has also issued a report on laboratory porcelain. Among other points we notice a summary of discussions on the qualification conveyed by the title "chemist," and on the further organisation of the profession of chemistry. Other topical matters dealt with are the second report of the Committee of the Privy Council on Scientific and Industrial Research, the report issued by the Fuel Research Board, and the first report of the Board of Scientific Societies.

Northampton Polytechnic Institute.—At the annual prize distribution last Saturday, the principal (Dr. R. Mullineux Walmsley) referred to the effect of the war on the educational and social work of the institution. As regards the engineering day classes, the manufacture of high-class munitions upon a commercial scale, which commenced on July 1, 1915, had been continued without interruption up to the present time. The day students still furnished the bulk of the producers engaged in the shops, and many had attained a high degree of skill. The technical optics department was less fortunate than the engineering department, owing to the nature of the industry, being much affected by the war. But the work of training women students in full time courses in lens and prism grinding had been vigorously carried on, a constant stream of workers for optical shops in England, Scotland and Ireland being provided. Enrolments for evening classes were still below the pre-war standard, but as regards 1917-1918 the corner appeared to have been turned, and an improvement was manifest. Good work was also being done in training disabled soldiers and sailors as electric power sub-station attendants, and other special courses suitable for disabled men had been developed.

Obituary.

SIR JOHN WOLFE BARRY.—As we go to press we learn with regret of the death of Sir John Wolfe Barry, K.C.B., F.R.S., which occurred on Wednesday. A full obituary notice will appear in our next issue.

J. SHRIMPTON.—We also regret to record the death, after quite a brief illness, of Mr. J. Shrimpton, accountant and commercial assistant to the Weston Electrical Instrument Co. for nearly twelve years.

JOHN S. SELLON.—We also regret to learn of the death of Mr. John [illegible] Sellon, which took place in London on the 15th inst. Mr. Sellon, who was born in 18[illegible], was the [illegible] son of Capt. William Baker Sellon, R.N. [illegible]

He played a prominent part in the researches and industrial development connected with the platinum and other groups of rarer metals, with which the name of his firm is associated. Quite early in the history of electric lighting Mr. Sellon interested himself in its development, and he was a consistent advocate of its advantages from the early days. Mr. Sellon took out many patents in connection with secondary batteries and their manipulation. His first patents were taken out in 1881, and in that year his residence at Sydenham was fitted up throughout with the electric light, the lamps being run from accumulators. This was, we believe, the first private house in the world which was so lighted in its entirety. Mr. Sellon was, until its amalgamation with the Electric Construction Corpn. in 1889, vice-chairman of the Electrical Power Storage Co., which worked his patents in conjunction with those of Faure, Swan, [illegible] and others. He was for 10 years (from its first initiation) vice-chairman of the Anglo-American Brush Electric Light Corpn. (now the Brush Electrical Engineering Co.).

COL. BOUGHEY.—The death is announced of Col. Geo. F. O. Boughey, C.S.I. (late R.E.), who was until recently one of the Light Railway Commissioners.

Deaths on Active Service.—The following deaths are reported:—

Capt. W. Alan Fraser (R.E.), formerly electrical engineer and tramways manager at Nelson, has been killed in action. He came from South America to join the army on the outbreak of war.

Pte. H. J. Bishop (The Buffs), formerly in the India Rubber Co.'s instrument department, was killed on Nov. 20 [illegible]

L.-Corp. S. Davies (R.E.), senior partner of a Cardiff firm of builders, and an instructor in wireless telegraphy in the R.E., [illegible]

Personal.

Mr. Thomas D'Arcy Nassau, A.M.I.E.E., engineer and manager to the County of Dorset Electric Supply Co. (and to the Swanage, Lyme Regis, and Blandford companies) has been released by the directors for service with the Army and has been appointed to a Commission in the Royal Flying Corps.

The President of the Board of Trade has appointed Mr. H. F. Carhill to be Assistant Secretary (in charge of the Industrial Power and Transport Department) and Mr. Percy Ashley to be Assistant Secretary (in charge of the Industries and Manufactures Department).

MILITARY HONOUR.—The following honour has been conferred:—

Pte. P. Alexander (Welsh Regiment), formerly a Wallasey tramcar driver, has been decorated with the Military Medal.

WAR CASUALTY.—The following casualty is reported:—

Pte. F. Connell (King's Liverpool Regt.), a former employee in the Blackpool electricity department, has been wounded.

Arrangements for the Week.

FRIDAY, Jan. 25th (to-day)

PHYSICAL SOCIETY.

5 p.m. At the Imperial College of Science, South Kensington, London, S.W. Presidential Address by Mr. C. V. Boys, F.R.S.

ROYAL INSTITUTION.

5.30 p.m. At 21, Albemarle-street, London, W.1. Discourse on "The Motions of Electrons in Gases," by Prof. J. S. Townsend, F.R.S.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

6 p.m. At the Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne. Address on "Trade and Industrial Reconstruction," by the Rt. Hon. C. Addison, [illegible] M.P. (Minister of Reconstruction).

SATURDAY, Jan. 26th.

ROYAL INSTITUTION.

3 p.m. At 21, Albemarle-street, London, W.1. Lecture on "The Chemical Action of Light," by Prof. W. J. Pope, F.R.S. (Lecture II.)

MONDAY, Jan. 28th.

ROYAL SOCIETY OF ARTS.

4.30 p.m. At John-street, Adelphi, London, W.C. 2. Cantor Lecture on "High Temperature Processes and Products," by Mr. C. R. Darling. (Lecture III.)

TUESDAY, Jan. 29th.

[illegible]

7 p.m. [illegible] Paper on [illegible] by Mr. [illegible]

FRIDAY, Feb. 1st.

[illegible]

[illegible]

A Modern Granary.

THE EQUIPMENT OF THE CLYDE TRUSTEES' NEW GRANARY AT MEADOWSIDE.

(*Concluded from page 573.*)

Synopsis.—This granary has a storage capacity of 31,000 tons of wheat. It is provided with an extensive equipment of conveyors and elevators, so that the wheat can be unloaded from boats and be delivered to any one of the 12 floors; and, conversely, so that loading of all kinds can be effected with a minimum of labour.

INTAKE PLANT FOR SACKED GRAIN.

10. *Inclined Sack Conveyor-Bands.*—Two bands, each capable of dealing with 500 sacks of wheat per hour, are provided at the west and east ends respectively of the floor granary. Both start from the floor of the goods shed, a short distance from the front at the quayside, and, rising therefrom at an angle of about 17 deg., enter the granary at the sixth floor level, being carried over the space between the shed and the granary by overhead steel gantries or bridges which form a passage from the shed to the sixth floor. Inside the shed the first lengths of these bands are hinged, and can be raised up close to the roof when not in use, leaving the parts of the shed floor underneath them available for general cargo. Sacks are discharged from the ship's hold on to the quay, and wheeled to the foot of the inclined bands, where they are weighed and placed on the bands, by means of which they are delivered into the granary, at the sixth floor, on to a reversible horizontal conveyor-band running from west to east, which in turn delivers the sacks by means of a travelling "throw-off" at seven points on each side of the band. The sacks may then be piled up on the sixth floor, or dropped through any one of the nine sack shoots to any of the lower floors, or direct to the appliances at ground level for loading into lorries, railway wagons or lighters alongside the quay. The general arrangement is seen in Fig. 2.

In order to provide for sacks being taken to floors above the sixth, there is a continuation of the east intake conveyor-band to the twelfth floor, consisting of a short inclined sack-band, passing upwards through the seventh floor at the east end of the granary, leading to an inclined band running alongside the north wall up to the eleventh floor, which delivers sacks on to another short inclined cross-band, leading to a horizontal band, running from west to east along the centre of the twelfth floor.

only is required to handle each sack in taking it from the shoot and loading it in the wagon.

By the "Swiftsure" shoots sacks may be passed down through one or more floors, the sacks being stopped by the operation of a flap valve at the floor desired. At every floor doors are provided on each side of the shoot for taking delivery of sacks and, at the end of the shoot, for passing in sacks.

12. *Loading Out Bulk and Sacked Grain.*—When grain is being drawn from any of the bins or floors to be loaded in bulk into carts or railway wagons, it may be weighed in the portable automatic weighers on the first floor described later, and thereafter loaded by means of portable shoots. If the grain is to be loaded into lighters at the quay it is similarly passed, after weighing, to the basement conveyor-bands described in the next paragraph, and by them delivered to the loading-out band in the transverse subway between granary and quay.

13. *Conveyor-Bands in Basement.*—Below the loading platforms are six subways—three under the silos and three under the floors—containing six conveyor-bands numbered F1, 2, 3, each 163 ft. long, and F4, 5, 6, each 127 ft. long between the centres of the terminals (Fig. 2). These convey grain, either sacked or in bulk, from the extreme ends of the granary towards the cross subway, each delivering on to the loading-out band G. The grain is fed on to the F bands from any part of any floor, through any of the 61 down spouts, or from any bin through portable shoots. Each set of three bands is driven from one of the two countershafts in the cross subway, each shaft being driven through suitable spur gearing by a

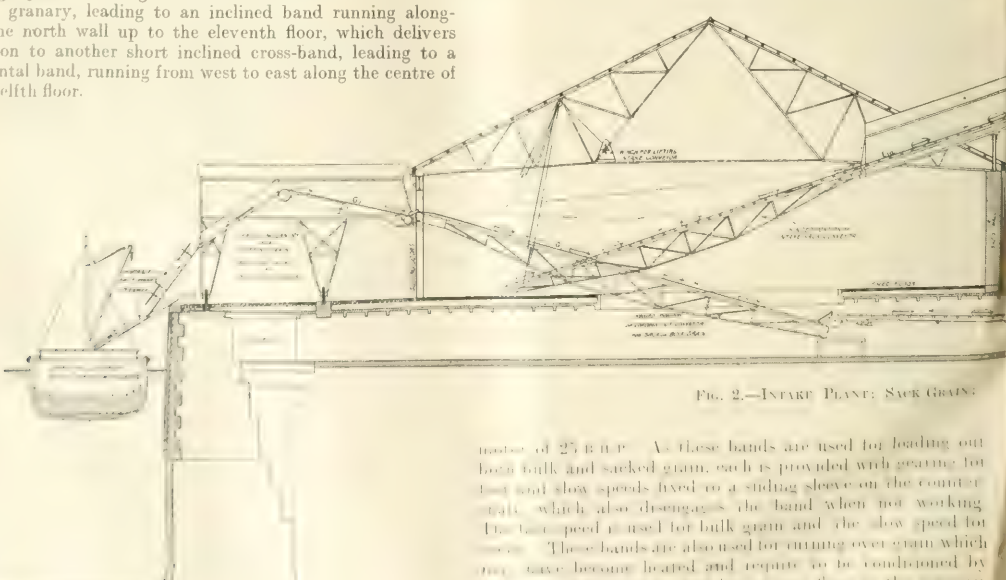


FIG. 2.—INTAKE PLANT: SACK GRAIN.

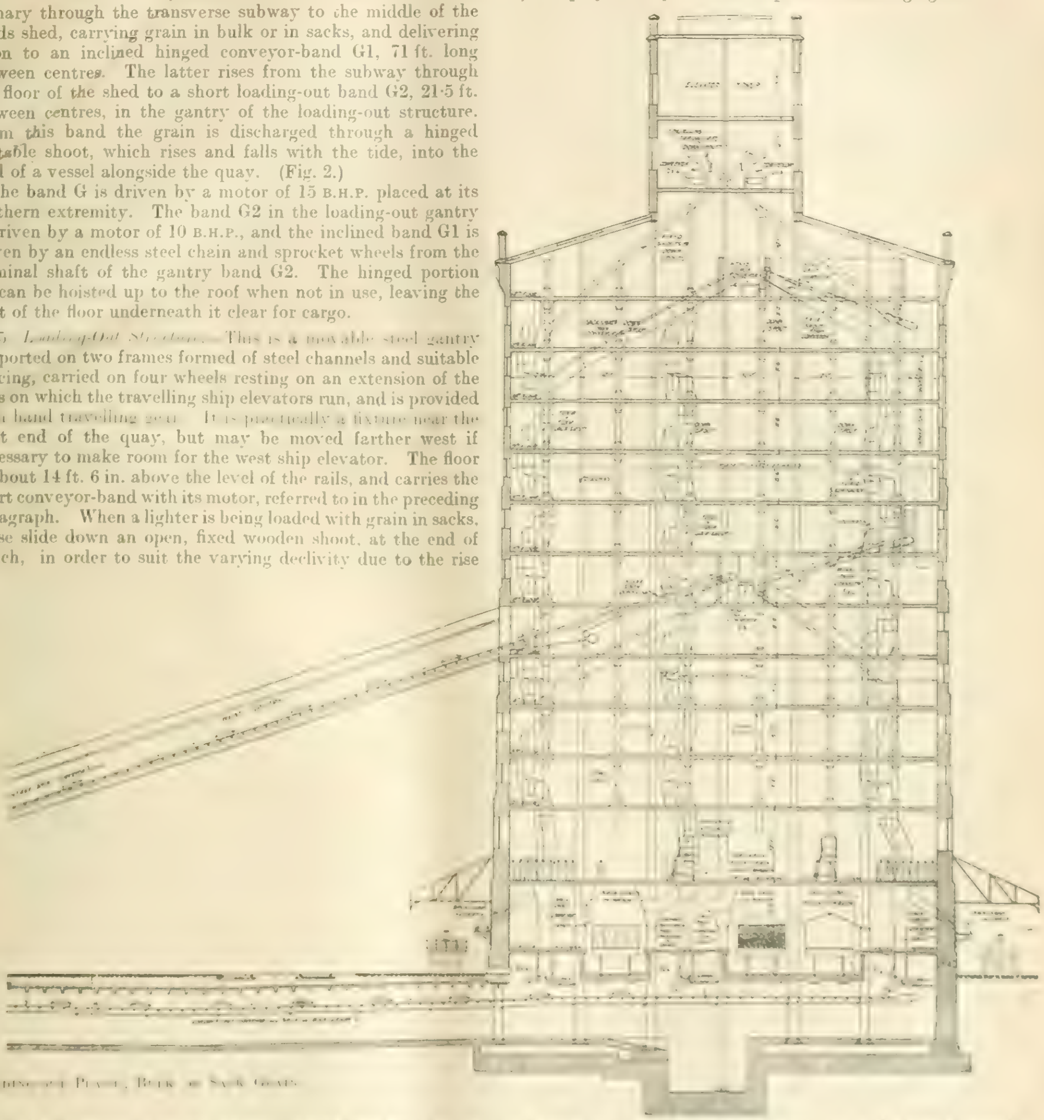
motor of 25 B.H.P. As these bands are used for loading out both bulk and sacked grain, each is provided with gearing for fast and slow speeds fixed to a sliding sleeve on the countershaft, which also disengages the band when not working. The fast speed is used for bulk grain and the slow speed for sacks. These bands are also used for turning over grain which may have become heated and require to be conditioned by its removal from or to any bin or any floor in the granary. Two short supplementary bands F7 and 8, each 24 ft. between the centres of the terminals, are arranged at the north end of the cross subway to feed grain from the two north bands F1 and F6 into the boots of the elevators when turning over. These bands F7 and 8 are worked from a cross shaft driven by bevel gearing and belts from one of the countershafts, and are provided with suitable clutches and handles for putting either of them in and out of gear.

11. [illegible]

14. *Loading-Out Conveyor-Bands in Transverse Subway.*—The conveyor-band G, which is 163·5 ft. long between the centres of the terminals, extends from the north side of the granary through the transverse subway to the middle of the goods shed, carrying grain in bulk or in sacks, and delivering it on to an inclined hinged conveyor-band G1, 71 ft. long between centres. The latter rises from the subway through the floor of the shed to a short loading-out band G2, 21·5 ft. between centres, in the gantry of the loading-out structure. From this band the grain is discharged through a hinged portable shoot, which rises and falls with the tide, into the hold of a vessel alongside the quay. (Fig. 2.)

The band G is driven by a motor of 15 B.H.P. placed at its southern extremity. The band G2 in the loading-out gantry is driven by a motor of 10 B.H.P., and the inclined band G1 is driven by an endless steel chain and sprocket wheels from the terminal shaft of the gantry band G2. The hinged portion G1 can be hoisted up to the roof when not in use, leaving the part of the floor underneath it clear for cargo.

15. *Loading-Out Structure.*—This is a movable steel gantry supported on two frames formed of steel channels and suitable bracing, carried on four wheels resting on an extension of the rails on which the travelling ship elevators run, and is provided with hand travelling gear. It is practically a fixture near the west end of the quay, but may be moved farther west if necessary to make room for the west ship elevator. The floor is about 14 ft. 6 in. above the level of the rails, and carries the short conveyor-band with its motor, referred to in the preceding paragraph. When a lighter is being loaded with grain in sacks, these slide down an open, fixed wooden shoot, at the end of which, in order to suit the varying declivity due to the rise



Loading-out Plant, Bulk or Sack Grain.

and fall of the tide, is hinged a portable wooden shoot having two adjustable spring boards at the sides, which can be regulated to suit different sizes of sacks. The hinged shoot for bulk grain is a light steel pipe having a [illegible] hopper at the upper end, the lower end being led into the hold of the vessel alongside the quay.

16. *Motors.*—All are of the totally enclosed type, with dust-proof bearings, the system of supply being 500 volts direct current. Each is capable of carrying overloads of 25 per cent. for half an hour, and of 50 per cent. for five minutes without sparking. The windings are of the Admiralty type throughout. There are altogether [illegible] motors throughout the granary [illegible] a total of [illegible] B.H.P.

A dust-collecting plant is provided for the [illegible], the arrangement consisting of [illegible] fans and

with two dust cyclones, all dust connections and sacking-off arrangements for the dust. There is also a ventilating fan for the quay subway. This is capable of discharging from the subway 22,000 cub. ft. of air per minute with free inlet and outlet.

For communication with the various parts of the granary it has been found that telephones are unsuitable in some parts of the granary, [illegible] it is difficult to hear distinctly what is said. A system of [illegible] has therefore been arranged.

17. *Transit to Railway Wagons* (Fig. [illegible]).—At the [illegible] end of the granary [illegible]

Table.—*Current Used in Discharging, Weighing and Delivering Wheat from the Hold of a Vessel into One of the Bins.*

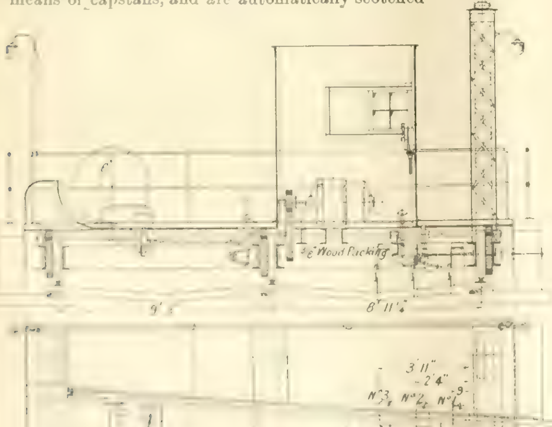
—	H.P. of motor.	Running loaded. Kw.	Running light. Kw.	Effective Kw. $= B - C$.	Efficiency % $= \frac{H \times 100}{B}$	Grain raised by ship elevator. Lb. per minute.	Height. ft.	Ft.-lb. per minute.	Equivalent kw. Output.	Total effic. of the system % $\frac{K \times 100}{B}$	Kw. per ton per hr. $\frac{B}{283}$
	A	B	C	D	E	F	G	H	K	O	
Ship elevator (east)	40	36·944	7·28	29·664	80·29	10,560	82·0	865,920	19·575	53·0	0·1305
Weighing elevators—two driven by one motor	30	19·631	4·096	15·535	79·13	Equal to 283 tons per hour.	48·75	514,800	11·637	59·28	0·0658
Granary elevator, C1......	65	55·913	4·135	51·778	92·6		171·0	1,085,760	40·819	73·0	0·1976
—	Conveyor bands.						Length between centres in feet.	Speed of band in f.p.m.	R.p.m. of motors.	Feet of band per revolution of motor.	—
B 5 in quay tunnel	30	20·746	11·264	9·482	45·7	10,560	329	800	600	$1\frac{1}{3}$	0·0733
B 7 in cross tunnel	30	17·0	10·042	6·958	40·93	Equal to 283 tons per hour.	$244\frac{1}{2}$	800	600	$1\frac{1}{3}$	0·0600
D 2 in gallery	30	15·655	11·684	3·971	25·36		168	800	600	$1\frac{1}{3}$	0·0140
											0·5412

Full capacity of one band only.—The average load per lineal foot on band $= 10{,}560 \div 800 = 13·2$ lb., at 60 lb. per bushel $= 0·22$ bushels $= 488$ cubic in.; bands 30 in. wide. The average depth of grain on band when conveying 283 tons per hour $= 488 \div (12 \times 30) = 1·35$ in. A bushel $= 2{,}218·19$ cubic in.

length of travel of the traverser is approximately 100 ft., and the speed, with a load of 18 tons, is on an average about 180 ft. per minute. The traverser is driven by a compound-wound motor of 12 B.H.P., which runs at a speed of 450 r.p.m. when at full load.

The wagons are run on and off the traverser by means of capstans, and are automatically scotched by means of [illegible] blocks operated by a [illegible] actuated by the [illegible] of the waggon wheels. The blocks are [illegible] by a hand lever.

A locking bar is provided for fixing the [illegible] in place at the running on or off positions, and this is operated by means of a foot pedal fixed to the floor of the motor house, and so interlocked with the controller that current cannot be supplied to the motor unless the locking bar has been withdrawn by the operator.



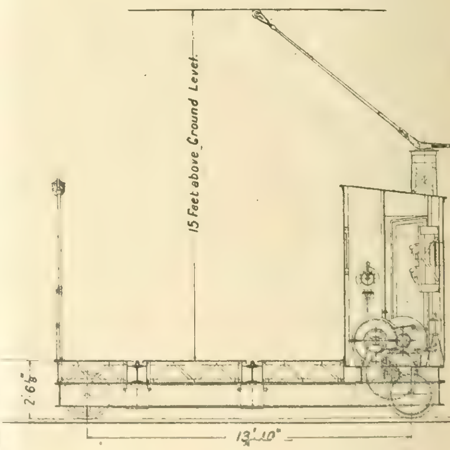


FIG. 3.—GENERAL ARRANGEMENT OF TRAVERSER.

The control gear consists of a master controller, with notches corresponding to the various positions from which the waggons are run off and on. Two "inching" push buttons are provided to adjust the rails of the traverser in line with the fixed rails. Position switches, fully watertight, are fitted on the body of the carriage, and operated by tappets fixed on the side of the pit, and limit switches are fixed at each end of the pit to prevent over-running.

Current is supplied by overhead bare wires carried on four steel poles, fitted with brackets at the top for carrying the insulators and strainers, and is collected by a double-arm trolley pole mounted on a lattice work column at one corner of the traverser.

Electric Ploughing.*

By A. DELAMARRE.

The lack of labour, and the necessity for increasing the yield of the land, have inevitably tended towards the industrialisation of agriculture during the past three years. The application of mechanical aids has now reached a favourable stage, and farmers have at last been induced to overcome their repugnance to the use of machinery. M. Lecler has shown how well founded are the hopes based on the results of the application of electrical methods in agricultural problems,† in particular as regards the use of cable-driven implements for breaking up the ground. I entirely agree with him that if is not necessary to look to tractors to secure deep working of soil.

M. Lecler recalled that the Germans have made exhaustive tests of electrical methods and have more or less come to the conclusion that they would not yield the results anticipated. But it is desirable to avoid hasty conclusions on this point, and it occurred to me that it would be useful to summarise our recent experiences in this field, including those which appear to have lead to promising results. A problem that is clearly stated is half solved.

AMOUNT OF POWER NECESSARY IN TRACTION.

Let us first attempt to estimate the power necessary in ordinary ploughing operations. While recognising that the expenditure of power depends necessarily on the depth of working, it is convenient to evaluate the specific effort needed in terms of kilogrammes per square decimetre of the furrow section. One must, however, also bear in mind the varying nature of the soil.

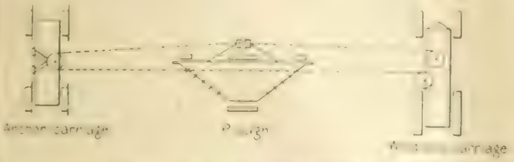


FIG. 1.—PLOUGHING WITH SINGLE WINCH.

A series of dynamometric tests undertaken by M. [illegible] led him to formulate the following requirements :—

[illegible]	[illegible] dm².
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

[illegible]

[illegible]

[illegible]

efficient of utilisation " rarely exceeds 0·65, for it is impracticable to work continuously for more than two-thirds of the time, so that in practice one could not count on covering more than about 0·65 $\times$ 5·4 = 3·5 hectares (8·7 acres).

With a plough operated with powers exceeding 90–100 H.P. one might reach 5 or even 6 hectares per hour. But, as we shall see shortly, it is not desirable to increase too far the power of the winch operating the plough, as this involves a corresponding increase in the weight.

VARIOUS SYSTEMS OF TRACTION.

Whatever the motive force applied we have the choice of two distinct methods of driving the plough, (1) by tractors ; (2) by the winch.

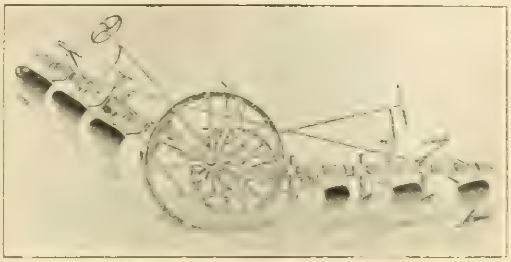


FIG. 2.—TYPICAL THREE-BLADED PLOUGH.

Tractors or motor-ploughs have the grave drawback that they absorb a great proportion of the power in advancing over loose soil, which constitutes the worst material to move on that can be imagined. The loss in this respect may amount to 60 per cent. In addition their useful application to ploughing is diminished by difficulties arising from the adherence of the soil, which may vary in the proportion of 1 : 3·6. It seems desirable, while not a priori condemning the tractor system, to put aside such methods for the moment, seeing that a highly promising solution of the problem is afforded by the Zimmerman system, on which more will be said shortly.

[illegible] present time, thanks to the improvements introduced by Fowler, [illegible] possible methods are available. (1) those using a single winch, and [illegible]

FIG. 3.—[illegible]

In the first process the single winch is displaced laterally in pro- [illegible] carriage. (*See* Fig. 1.)

[illegible]

[illegible]

[illegible]

* [illegible]

† [illegible]

The [illegible] of a single winch has one great advantage, namely, that the first cost is about half that involved in the second process. Moreover, only a single cable for the conveyance of electric energy is required. On the other hand it takes more time to put in operation, the tractor-cable length is doubled, and the anchorage of the movable pulley is somewhat difficult to undertake successfully. Its greatest disadvantage, however, is that it is only applicable to flat land, for it is essential that the man in charge of the winch should be able to watch the progress of the plough and comply with the signals of the man directing it. On the other hand the double winch system allows a furrow as long as 600 metres to be operated and can be used on sloping ground, or even in a mist or fog. It is, therefore, the system most commonly employed in all work of this kind, whether steam or electricity be the motive power.

TRACTORS.

In spite of their inconveniences such as the adherence of soil, and the low efficiency often resulting therefrom, it is impossible to ignore entirely the operations of tractors and motor-ploughs. Results already obtained with such machines operated by alcohol, benzol, &c., show that they cannot be used where very powerful forces are needed, as, for example, in working to great depth. But this does not imply that they cannot be used for ordinary light work, *e.g.*, to depths of 15–18 centimetres, for removing stubble, &c.

In fact a serious effort in this direction has been made during the last dozen years by the firm of Zimmerman, of Halle, in Germany, and it is necessary to give some account of this system.

In this case the plough *c* (Fig. 4) is of the "balance" type, illustrated in Fig. 2, and receives current from a strongly insulated cable *L* supported by carriers V V_1, which are at distances of about 40 metres. The plough moves in the same way as an infant, *i.e.*, it

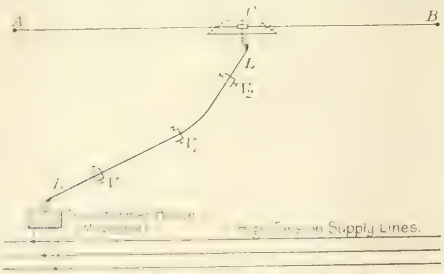


FIG. 4.—[illegible] OF ZIMMERMAN SYSTEM AND ELECTRICAL PLOUGHING.

drags itself forward (and it is this motion that gives interest to the process) on the chain *AB*, fixed to the two extremities of the field, [illegible] the power being supplied by the motor mounted on the plough itself. At each end of the furrow a commutator enables the direction of motion to be reversed, [illegible]

[illegible] at each extremity, weighing [illegible] and displaced by a [illegible] at the end of each furrow.

[illegible] exceeds 50 per cent. Its price, inclusive of the chain, the two anchors, and 600 metres of [illegible] the running cost, for deep work [illegible] and with current at 0·19 fr. per unit, is [illegible]

[illegible] the advantage of rendering the man [illegible] and can, therefore, [illegible] the material being light and [illegible] requires a motor of [illegible] It was introduced into France by M. [illegible] improvements.

Although the Zimmerman plough has [illegible] distinct advantages, [illegible] at the period [illegible] to agriculture [illegible] the imperfect [illegible] constituted a [illegible] to be taken [illegible]

[illegible]

[illegible]

de Turin and Morelli. Finally French manufacturers such as Jeumont and Fillet took the matter in hand. Two types have proved their worth, those of Siemens and Fillet; while a third, developed several months after the outbreak of war, that of the Société de Constructions de Nord et de l'Est (Jeumont) has received little application as yet, but has yielded promising results.

FIG. 5.—SIEMENS ELECTRICAL WINCH AND PLOUGH.

The Siemens Winch.—This was the first to give satisfaction, and is used especially in Germany and in Spain. Two types exist, that intended to operate with an anchor-carriage at the outer extremity of the field, and that working with the winch in duplicate. The first only differs from the second in having two drums, controlled alternatively by the same motor. This type is illustrated in Fig. 5, and its chief characteristics are shown in Table I.

Table I.

Particulars of System.	Single Winch.	Double Winch.
Dimensions of carriage ...	6·4 m. × 2·6 m.	6·6 m. × 2·6 m.
Dimensions of front wheels	1·3 m. × 0·35 m.	1·3 m. × 0·35 m.
Dimensions of back wheels	2·3 m. × 0·5 m.	1·8 m. × 0·5 m.

The winch utilises an electric motor of 60–90 H.P., which is enclosed so as to be protected against all weathers. The winch carries drums capable of unwinding 400–500 metres of cable, and allows two speeds, namely, 1·1 m. and 1·6 m. per second. The tractive effort is exerted perpendicular to the longitudinal axis of the carriage. The train of gear-wheels can be engaged either with the winch or with the back wheels of the carriage so as to enable the latter to be moved across the direction of the furrows. The diameter of the engaging gear-wheels is small, thus facilitating turning awkward corners. The motor is controlled by a regulator similar to that employed on tramways. Connection between motor and winch is made through a belt which serves to take up the shock when the plough encounters roots, stones or other obstacles. The tractive effort is about 4,000 kg.

The anchor-carriage (*see* Fig. 6) does not present any special

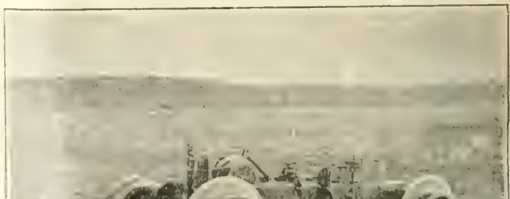


FIG. 6.—SIEMENS ANCHOR-CARRIAGE.

[illegible] except that it is fitted with disc wheels, which become [illegible] imbedded in the earth. It displaces itself automatically [illegible] to the progress of the work.

The only objection, unfortunately, a not inconsiderable one [illegible] about 13 tons), which renders the transport [illegible] apparatus a difficult and inconvenient process.

(*To be concluded.*)

Interconnection of Electricity Supply Undertakings in the West of Scotland.

A report has been issued by the West of Scotland Committee for the Interconnection of Electricity Supply Undertakings. Some details of this report were given in our issue of the 11th inst., but owing to its importance we now deal with it at greater length. The committee consists of Messrs. Geo. Balfour (Scottish Central Company), acting as chairman, F. H. Whysall (Greenock), acting as vice-chairman and hon. secretary, R. A. Brown (Falkirk), G. F. Moller (Lanarkshire Tramways Co.), G. Salter (Hamilton), Jas. Wishart (Motherwell), C. F. Parkinson (Paisley), Fred. Coutts (Paisley), Roland Marshall (Ayr), C. T. Astbury (Wishaw), J. Dalrymple (Tramways Dept., Glasgow), J. White (Kilmacolm), Thos. Ross (Cambuslang), D. A. Starr (Clyde Valley Co.), H. E. Ferguson (Clyde Valley Co.), E. C. Churchward (Falkirk, since deceased), H. C. Babb (Bo'ness), J. W. Napier (Alloa), J. W. Papworth (Stirling), W. C. Bexon (Kilmarnock), E. T. Goslin (Tramways Dept., Glasgow), W. W. Lackie (Glasgow), A. Page (Clyde Valley Co.), F. J. Launchbury (Coatbridge), and H. Dixon (Dumbarton).

The area covered by this report includes the Counties of Renfrew, Clackmannan, Linlithgow and portions of the Counties of Ayr, Dumbarton, Lanark and Stirling.

In order to facilitate investigations as to the possibility of, and advantages to be derived from, inter-connection, the local authorities and companies operating electricity supply undertakings within the above-mentioned area have been arranged in groups according to their geographical proximity and similarity of supply systems, and are presented below in the order in which they are dealt with in this report :—

A. PAISLEY, GREENOCK AND KILMARNOCK.

1. Paisley Corporation.
2. Greenock Corporation.
3. Kilmarnock Corporation.
4. Kilmacolm Electric Co.

B. [illegible]

1. Glasgow Corporation Electricity Department.
2. Glasgow Corporation Tramways Department.
3. Clyde Valley Electric Power Co.

C. [illegible]

1. Alloa Corporation.
2. National Electric Construction Co., Bo'ness.
3. Falkirk Corporation.
4. Scottish Central Electric Power Co. (near Falkirk).
5. Stirling Corporation.

D. [illegible]

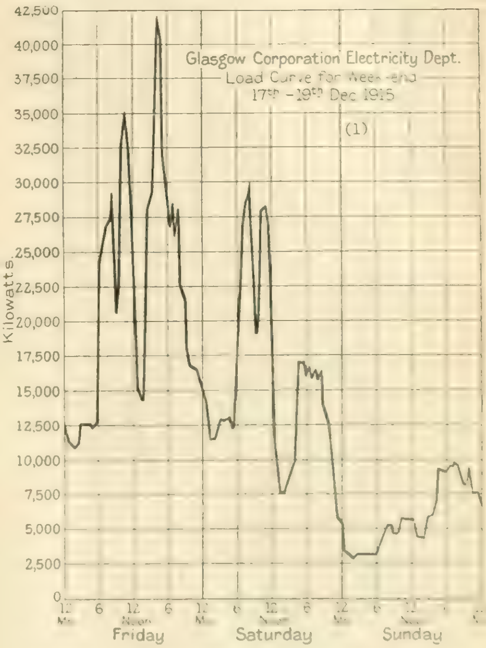
1. Lanarkshire Tramways.
2. Motherwell Corporation.
3. [illegible]
4. [illegible]

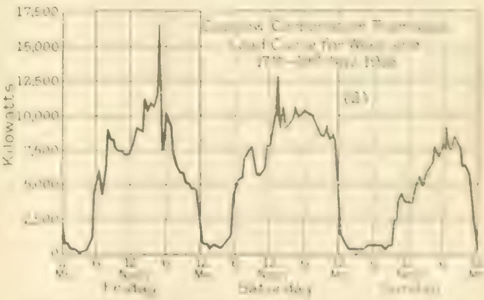
[illegible]

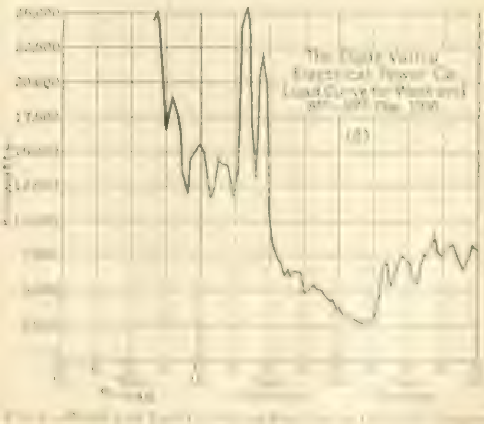
Table.—[illegible]

	Group A	Group B	Group C	Group D
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]







[illegible]

B. *Glasgow and Clyde Valley District.*—The three undertakings in this group furnish supplies at a periodicity of 25 cycles. Two of these are already linked up to some extent, and the committee have been informed by the managers of these undertakings that it is only necessary to install from 4,000 kw. to 6,000 kw. of static transformers at the Dalmarnock station of the Glasgow Corporation to provide a link of maximum utility, at a cost of about £16,000. Assuming that full advantage is made of the inter-connection between these three undertakings, and allowing a small average increase in economy of 0·1 lb. of coal per unit generated, the annual saving would approximate £10,000.

The week-end load curves of the undertakings are shown in Figs. 1 and the combined load of all the groups in Fig. 2.

C. *East Central District.*—The undertakings in this group all generate direct current, with the exception of the Scottish Central Power Co., whose system is three-phase 50 cycles, and a portion of Falkirk Corporation supply, which is also three-phase 50 cycles.

At a sub-committee meeting held on January 24, 1917, when representatives of the various undertakings in this group were present, it was generally agreed that the only feasible manner in which inter-connection could be carried out would be by making use of the Scottish Central Power Co.'s mains, and extending the same to each of the systems in the group.

The combined week-end maximum load of the whole of the undertakings does not exceed 2,000 kw., of which 1,500 kw. is due to the Scottish Central Co., while for the greater part of the week-end the combined load is about 1,000 kw., of which 750 kw. is the Scottish Central load. The week-end load of the whole of this group could be carried comfortably by the Scottish Central Co., enabling Stirling, Falkirk, Alloa and Bo'ness to be shut down during the period of the light loads. The necessary cables, transformers, rotary machinery and switchgear for this purpose would involve an expenditure of approximately £16,000, while the aggregate saving in fuel to be effected by the five undertakings for each 0·1 lb. per unit generated would be £500, and the committee believe that an annual saving of approximately £1,000 would be realised by linking up.

The committee are of opinion that the linking-up for week-end supply might be advantageous to some of the undertakings in this group, but that greater economy could be effected if the smaller stations were supplied in bulk from the larger.

D. *Lanarkshire District.*—These four undertakings all generate direct current. Their maximum loads occur at practically the same time, and it would not be possible, with existing plant, to carry the combined week-end load on any one station. The expense of heavy direct-current cables which would be necessary for linking these undertakings would not, therefore, be justified either for interchange of supply or for week-end running, but future requirements should be met by high-tension bulk supply.

In addition to the inter-connection of the undertakings within each group considered in the foregoing, the linking-up between groups has also been investigated, and the committee arrived at the following conclusions:—

Group E (A and B).—The only practical manner in which these groups might be linked up would be by means of a link between Clyde Valley (25 periods) and Paisley (50 periods). Calculating on a link of 1,000 kw. capacity, the total cost of mains, rotary machinery, &c., was found to be approximately £12,870, while the annual saving to be expected from these interchange of energy would not exceed £1,040.

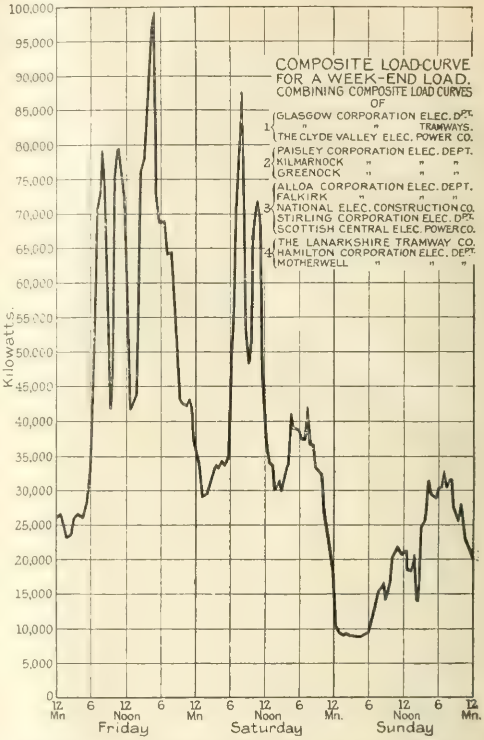


FIG. 2.—COMPOSITE WEEK-END LOAD CURVE OF ALL THE GROUPS.

Group F (B and D).—The undertakings in Group D are all within the Clyde Valley area, and the Lanarkshire tramways are already supplied from the Clyde Valley Co. at several points. Linking-up these groups

Table II.—*Schedule of Particulars Relating to West of Scotland Electricity Undertakings.*

Undertaking.	System.	Voltage.	Max. load in kw., winter 1916-17.	Capacity in kilowatts. Generators. Kw.	Boilers. Kw.	Spare boilers at "peak" load. Kw.	Remarks.
[illegible]	Direct current	440	668	1,201	Gas plant.	...	......
[illegible]	[illegible]	460	700	1,000	800	100	......
[illegible]	[illegible]	11,000	25,000	40,000	33,000	8,000	Bulk supplies to Wishaw, Coatbridge, Airdrie and Dumbarton. A number of other towns and villages in the area are also supplied by the company. Extensions of 20,000 kw. are in progress.
[illegible]	[illegible]	[illegible]	950	[illegible]	[illegible]	...	......
[illegible]	[illegible]	[illegible]	45,000	55,000	[illegible]	10,000	Extensions of 30,000 kw. are in progress. Already linked
Glasgow Corp. Tramways .	[illegible]	[illegible]	18,000	[illegible]	[illegible]	...	
[illegible]	[illegible]	[illegible]	7,800	[illegible]	12,000	3,500	Includes supplies to town of Port Glasgow
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1,500	700	......
Kilmarnock Corporation ...	[illegible]	[illegible]	[illegible]	5,000	5,000	[illegible]	Includes supplies to a number of towns and villages in the district
[illegible]	[illegible]	[illegible]	[illegible]	175	[illegible]	...	......
[illegible]	[illegible]	[illegible]				...	Particulars not furnished
[illegible]	[illegible]	520	[illegible]	[illegible]	[illegible]		[illegible] kw. purchased from Clyde Valley Co. (not included in maximum demand)
[illegible]	[illegible]	[illegible]	[illegible]	6,400	3,500	[illegible]	......
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		...
[illegible]	[illegible]	[illegible]	[illegible]	6,000	[illegible]	[illegible]	Includes supply in bulk to town of Denny. A number of other towns and villages [illegible] from the company.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			

would involve the extension of the Clyde Valley Co.'s mains to each of the undertakings in Group D, and the provision of rotary machinery and switchgear, at a cost of approximately £15,000.

Assuming a supply to be given at week-ends, the fuel saving would be equivalent to £1,200 per annum. There would be other advantages, but the committee consider that linking-up for the single purpose of week-end supply to the stations in Group D from the Clyde Valley Co. cannot in the meantime be recommended.

Group G (B and C).—The linking-up of these two groups resolves itself into a question of inter-connecting the Clyde Valley system (25 cycles) with the Scottish Central (50 cycles). Having regard to the distance between these systems, and more particularly to the difference in periodicity, necessitating rotary machinery at a new station and special staff, linking-up is not recommended.

The Scottish Central system is, however, of the same periodicity as the Fife Power Co., whose area of supply is included in the East of Scotland area in the map issued by the National Electric Power Supply Joint-Committee, and the committee therefore suggest that the district served by these two undertakings would be better considered as a separate area, making three areas in the Scottish section.

Reviewing the subject of interconnection as a whole, the committee have come to the conclusion that financial benefit would be derived from linking-up for the purpose of interchange of energy, between several of the undertakings in the West of Scotland area. In some of the groups considered the economy of furnishing week-end supplies from one station might be doubtful, but they are of opinion that considerable economy could be effected in many of these cases by a supply in bulk from the larger to the smaller stations.

Turbo-Rotor Cap-Rings.

By R. ROBERTS.

(*Concluded from p.* 578.)

Summary.—The author investigates the calculation of stress in turbo-rotor cap-rings, and, by means of examples, shows how these stresses may be calculated for some commonly used designs. In conclusion, he summarises the points that may be considered when designing these cap-rings.

D. The "end-ring stress" can be defined as a stress caused by moments tending to turn the ring inside out.

If the load upon a cap-ring were concentrated at one point in an axial direction we should usually find that this point did not coincide with the centre of gravity of the section of the ring. This non-coincidence produces a moment about the centre of gravity of the section of ring.

Thus in Case I. and the ring shown in Fig. 1, the distance between the centres of supports is 8 in., the centre of gravity of the section is 3⅜ in. from the outer support, and the centre of the load is found to be 3⅝ in. from the outer support. The moment thus produced tends to lift the ring away from its support at the core end and press the cap-ring more heavily upon its support at the outer end. The total load in Case I. is 359,440 lbs. and the moment thus becomes

$$359{,}440 \times \tfrac{1}{4} = 90{,}000 \text{ lbs. in.}$$

The maximum stress at the core end will $= \dfrac{M}{2\pi Z}$.

Where Z = the modulus of the section about an axis normal to the axis of the ring passing through its centre of gravity. In Case I. this stress is 2,090 lbs. per sq. in.; whilst in Case II. the moment is 146,000 lbs. in., and the maximum end-ring stress is 3,400 lbs. per sq. in.

It has been suggested that the outer support will react against this end-ring moment. The radial strain of the cap-ring at this point is usually greater than that of the support, so that the support will have little or no effect in reducing this stress. Each case, however, should be investigated to see if this general rule may be applied.

E. Constructional stresses are always difficult to estimate. It is a common postulate of design that the initial or constructional stresses should be such that under running or full speed conditions there will occur no movement between the fitted joints of support and supported. Thus in these cap-rings, we should need to shrink them on to their supports with sufficient allowance to strain them to the same amount as will occur under running conditions. We must also allow for any expansion due to different coefficients of expansion and difference of temperature of ring and support.

The rings discussed here may be taken as examples. The maximum running stress may be 22,400 lbs. per sq. in., the support diameter 22 in., and Young's modulus for the ring material 16×10^6. The strain of the ring due to this stress is $\frac{1}{32}$ in. approximately. Allowing 70° F. rise in the cap-ring, and 60° F. rise in the support, we find the difference of expansion becomes

$$= 22\,(70 \times 10.4 \times 10^{-6} - 60 \times 6.3 \times 10^{-6})$$
$$= 0{\cdot}0072 \text{ in.}$$

Total strain $= 0{\cdot}038$ in.

In practice, however, such an allowance strains the projecting supporting lip of the cap-ring well beyond its yield point, and any attempt to obtain the postulated condition in this way is not to be commended.

The cap-rings are nevertheless usually pressed into place and the amount of the pressing allowance is settled more by current shop practice than by aught else; but the hypothetically proper initial straining is seldom, if ever, obtained satisfactorily. The net result is that constructional stresses are not equal to running stresses, and in this case they will not need to be considered when computing maximum stresses.

F. When summing up the different individual stresses at various points in the ring, care must be taken that the stresses added together are all of the same sign and act across the same section. The maximum stress in this ring is necessarily tensile in the two cases considered, and will occur at some point in the periphery at the core end. Here the stresses such as self hoop, load hoop and end-ring stresses are all tensile, and, therefore, may be added together.

In Case I.

Self hoop stress	10,400 lb.	per sq. in.
Load hoop stress (max.)	9,400	"
End ring stress	2,090	"
Total max. stress	21,890	"

In Case II.

Self hoop stress	10,400 lb.	per sq. in.
Load hoop stress	9,150	"
End ring stress	3,400	"
	22,950	"

The tensile stresses at the outer end will be less than these since the end-ring stress is compressive and therefore negative: 1,520 lbs. per sq. in. in Case I., and 2,480 lbs. per sq. in. in Case II. The total maximum tensile stress at the outer end is 18,280 lbs. per sq. in. for Case I., and 17,070 lbs. per sq. in. for Case II.

The support stresses do affect the maximum hoop stresses, but probably only to a very small extent and need not be considered in combination with the main stresses.

G. A more unusual construction, as employed by very few manufacturers, is shown in Fig. 4, where the outer end is left unsupported and sometimes not even reinforced by an outer ring. Such a construction has several favourable points, but necessitates a much heavier support than other designs. Some care is necessary to make certain that the load is evenly distributed around the periphery, otherwise moments occur which tend to distort the ring in much the same way as a circular link in a chain may be distorted. A stress produced by such moments we call a "link" stress, and such stresses may be added with other stresses, care being taken that such stresses are added algebraically.

The loads in the cap-ring [illegible] of the ring are [illegible]. In Fig. 5 is shown an elemental link loaded with two forces equal and opposite at opposite sides of the ring. Considering a

such a link. It will be seen that the tangents at points A and C tend to remain parallel—similarly points B and D. Further, that the tangents at points B and D will remain at right angles to tangents at point A and C. Therefore each quadrant is in equilibrium, *i.e.*, the total sum of the moments in each quadrant is zero.

Consider quadrant *A O D*. At point X there exists a bending moment

$$M_1 = \frac{W}{2}\,(R - R\cos(90-\theta))$$

$$= \frac{WR}{2}\,(1 - \sin\theta).$$

Between the points A and D such moments are all positive, *i.e.*, counter-clockwise about point A, and the sum of these moments must be balanced by an equal sum of moments to keep the quadrant in equilibrium. Calling this reacting moment M_2, we find that

$$\sum_0^{\frac{\pi}{2}} M = \sum_0^{\frac{\pi}{2}} M_2 - \sum_0^{\frac{\pi}{2}} M_1$$

$$= \sum_0^{\frac{\pi}{2}} M_2 - \sum_0^{\frac{\pi}{2}} \frac{WR}{2}(1-\sin\theta)$$

$$= 0.$$

Bearing this theorem in mind, we can find the bending moment at any point or any series of points in a link which is loaded symmetrically, such as those given for Cases I. and II. We will consider only the equivalent radial forces at the outer end given in Tables III. and IV. Any moments produced at the core end are counter-balanced by reactions from the support. The quadrant loadings given in the tables are assumed to be applied at definite points. The sum of the moments produced in a definite quadrant by radial forces similar to those given in the theorem above are balanced by the sum of reacting moments within that quadrant—these reacting moments are equal at all points within this quadrant.

In Table IX. is shown the working for Case I. as applied to Fig. 4. Each point in the quadrant is treated separately. Thus at a point D the sum of the acting moments is found by summing the product of half of each radial force and $R\,(1-\sin\theta)$ where θ is the angle of displacement of any force from point D. Only forces within 90 deg. on both sides of point D may be considered, and to find the sum of the acting moments in one quadrant we must therefore consider the forces in three quadrants. In our example $R=11$ in. and the angle between adjacent load points is 9 deg., θ is therefore 9 deg., 18 deg, 27 deg., &c.

At the base of columns called A, B, C, &c., the acting moments are added, and the sum of these totals is 1,974,128 lbs. in. The reacting moments is therefore one-tenth of this, viz. : 197,413 lbs. in. The difference between the acting and the reacting moments at each point gives us the actual bending moment at that section of the ring.

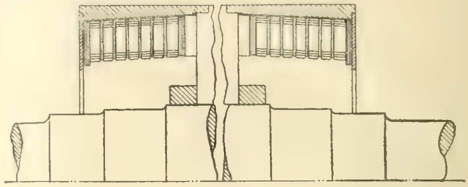


FIG. 4.

One end of the cap-ring is supported, and therefore the ring section immediately over the support is not affected by the moments distorting the other end, and the amount of distortion at a point in the section from support is proportional to the distance from that support.

We may find an equivalent moment of inertia of this ring, equivalent, that is, to a ring totally unsupported. We divide the ring section into sections and add the products of the moment of inertia of each section and its distance from the support. This sum divided by the distance of the extreme outer edge from support gives us the equivalent moment of inertia.

Table IX.

[illegible]	Positions.									
	A	B	C	D	E	F	G	H	K	L
L_1 3,370	0	..	...	...		...	...	...	...	...
K_1 3,870	262	0	...	...		...	...	...	...	...
[illegible]	[illegible]	292	0	...		...	...	...	...	...
[illegible]	[illegible]	1,265	318	0		...	...	...	...	...
F_1 5,060	[illegible]	3,040	1,360	342	0	...	...	...	...	...
E_1 5,340	[illegible]	[illegible]	3,200	1,440	362	0	...	...	...	...
D_1 5,600	[illegible]	9,020	5,880	3,360	1,510	379	0	...	..	...
[illegible]	[illegible]	12,800	9,100	5,930	3,390	1,520	382	0	...	...
[illegible]	[illegible]	[illegible]	12,800	9,100	[illegible]	3,390	1,520	382	0	...
A_1 5,650	[illegible]	21,500	16,950	12,800	9,100	5,930	3,390	1,520	382	0
[illegible]	[illegible]	[illegible]	21,500	16,950	12,800	9,100	5,930	3,390	1,520	382
[illegible]	[illegible]	31,100	26,250	21,500	16,950	12,800	9,100	5,930	3,390	1,520
[illegible]	[illegible]	[illegible]	31,100	26,250	21,500	16,950	12,800	9,100	5,930	3,390
[illegible]	[illegible]	[illegible]	26,000	30,800	26,000	21,300	16,800	12,700	9,020	5,880
E 5,340	[illegible]	[illegible]	[illegible]	24,800	[illegible]	24,800	20,300	16,020	12,100	8,600
[illegible]	[illegible]	[illegible]	15,180	19,200	[illegible]	27,800	23,500	19,200	15,180	11,450
[illegible]	[illegible]	7,570	10,650	14,100	17,850	21,850	25,850	21,850	17,850	14,100
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	16,400	20,100	23,750	20,100	16,400
[illegible]	[illegible]	[illegible]	[illegible]	6,230	[illegible]	11,610	14,700	18,000	21,300	18,000
[illegible]	[illegible]	[illegible]	2,020	3,540	[illegible]	[illegible]	10,110	12,800	15,670	18,530
L_2 3,370	0	[illegible]	910	2,020	3,540	[illegible]	7,630	10,110	12,800	15,670
K_2 3,870		0	262	1,040	2,320	4,060	6,230	8,770	11,610	14,700
H_2 4,320			0	292	1,165	2,590	[illegible]	6,950	9,780	12,960
G_2 4,700				0	[illegible]	[illegible]	2,820	4,940	7,570	10,650
F_2 5,060					[illegible]	342	1,360	3,040	5,320	8,150
E_2 5,340						0	362	1,440	3,200	5,600
D_2 5,600							0	379	1,510	3,360
C_2 5,650							...	0	382	1,520
B_2 5,650							..	...	0	382
[illegible]							..	..	...	0
M_1	[illegible]	[illegible]	[illegible]	209,574	[illegible]	[illegible]	187,424	180,271	174,814	170,944
M_2	197,413	−197,413	−197,413	−197,413	−197,413	197,413	197,413	197,413	197,413	197,413
M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	−9,989	−17,142	−22,799	−26,469

The equivalent moment of inertia of the section shown in Fig. 4 is 0·204 in.^{4}. The radial depth of ring at outer end is 0·918 in. So that the equivalent section is 0·918 in. $\times$ 3·18 in.

The modulus of this section is 0·445 in.^{3}, and since the maximum bending moment in Table IX. is 26,469 lbs. in., the maximum bending stress is 59,500 lbs. per sq. in. This is by no means the total stress, because there still occurs the self hoop, load hoop and end-ring stresses. The various stresses properly added together produce the resultant stress of 77,000 lbs. per sq. in., or 35 tons per sq. in.—sufficient to produce distortion, if not destruction, of the rotor, were the cap-ring made of any usual material. Cap-rings which are not supported at the outer end must therefore be made comparatively heavy in section, or will need to be reinforced at the outer end which reinforcement need not necessarily be supported upon the shaft.

The bending moments produced in Case II. are almost double those found for Case I., and would therefore require still heavier cap-rings.

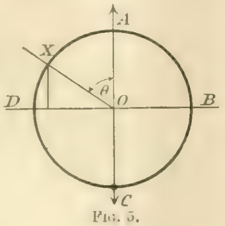


FIG. 5.

From these investigations the following points may be noticed as guides to the design of an end winding and cap-ring.

1. The end winding should, as far as possible, be designed to distribute the loads uniformly around the cap-ring. This is assisted by making the radii in the coil corners small and of the same magnitude in all coils.

2. The fittings of the cap-ring should be both socket, as shown in Fig. 1. A plug fitting at the outer support tends to increase the end-ring stress, and here expansion is likely to produce high stresses in the supporting lip.

3. The centre of gravity of the end winding should coincide in an axial direction with the centre of gravity of the cap-ring section.

4. The thickness of the supporting lips should be proportioned to carry any support shear forces without risk.

5. The cap-ring should be made of solid material or of material capable of withstanding high stresses in all planes, but especially stresses in circumferential direction.

6. The specific weight of the cap-ring material exercises considerable influence upon both the amount of metal used and the maximum peripheral speed permissible.

7. For the design shown in Fig. 4 the cap-ring would need to be much heavier than if the design shown in Fig. 1 were chosen.

Ten Years of Illuminating Engineering: Its Lessons and Future Prospects.

In a Paper on the above subject before the Illuminating Engineering Society on Jan. 15, Mr. L. Gaster recalled that just 10 years had elapsed since the starting of the movement of [illegible] illumination in this country. During the last decade there had been great advances in illuminants and methods of using light, and there was now much greater appreciation on the part of the general public of the importance of good illumination in daily life. An important feature in progress had been the improvements made in apparatus for measuring illumination. No branch of science could advance far until precise methods of measurement were available, and numerical data could be obtained. During recent years a great deal of information had been acquired regarding the amount and nature of the illumination desirable for various classes of work. Hundreds of illumination photometers, some for special test work, were now in use, whereas in the year 1907 few people knew what was meant by the term "foot-candle."

Turning to the work of the Society, Mr. Gaster remarked that it had fully justified its existence, and had acted as a corrective to undue specialisation, because it included many kinds of experts, who would otherwise have been left to grapple with lighting problems on individual lines, knowing little of what was being done by other branches of the subject. Another important characteristic was that both the user and the producer were represented. The illuminating engineer as a specialist could only be gradually evolved; his existence involved two conditions—a greater knowledge on the part of the public of the benefits of proper lighting, and fuller facilities for his own education. In the latter direction a start had been made in the years preceding the war by the organisation of courses at various educational centres; a very useful series had recently been arranged at the Pennsylvania University by the American Illuminating Engineering Society and had now been issued in book form.

Mr. Gaster next proceeded to discuss various methods of co-operation with other bodies. He mentioned the discussions on school, library and street lighting as good examples of such co-operation, which could be secured both through joint meetings and combined committees for the study of problems in detail. It was particularly desirable to enlist the help of the architectural and medical professions. He hoped that illuminating engineering would be studied to a greater extent by contractors and gas and electrical supply companies. In the future the latter would have to take special measures to cultivate good relations with consumers and afford them guidance on lighting matters. Even in the present circumstances the necessity for promoting economy in lighting matters had made it necessary for them to take consumers more fully into their confidence. Such companies should form illuminating engineering departments, and he suggested that lectures on fundamental points should be arranged by the Society for their illuminating engineering staffs. The Society could also assist manufacturers, contractors and supply companies by the organisation of local demonstrations and exhibitions showing model methods of lighting. A useful exhibition of this kind was organised in Berlin about 10 years ago, and in New York a block of shops had been specially lighted to serve as a model of what should be done. By the co-operation of municipal authorities it should also be possible to light sections of streets in the same way.

A very important matter at the present time was the relation of scientific and technical societies to the State. In the absence of proper channels of communication the only course for such societies was to offer their services whenever they saw an opening. In every case in which the Society had offered its services their suggestions had been sympathetically received, although in some cases they had not been acted upon. Opportunities for service must naturally be missed unless Government departments made a practice of approaching societies and stating the problems on which they desire guidance.

As instances of useful co-operation with Government departments Mr. Gaster mentioned the work of the Home Office Departmental Committee on Lighting in Factories and Workshops, the investigations now being carried on by special committees of the Society on the illuminating power of [illegible] and portable lights and [illegible] paint, and the recently formed Joint Committee on Illuminating Engineering under the Department of Scientific and Industrial Research. The Society in the United States had been afforded an opportunity of co-operating with the National Council of Defence on the lighting of arsenals, munition works, Government factories, &c., and there was no doubt that much good work had been done in this way. Under a recent Order the Ministry of Munitions had taken power to restrict lighting [illegible] for the [illegible] of the war; it was obvious that such powers should be exercised with great care and under expert advice.

In the concluding portion of his address, Mr. Gaster dealt mainly with the desirability of collecting accurate evidence of the effect of good lighting in preserving health, avoiding accidents, and improving output and quality of work. [illegible] just issued by the Ministry of Munitions Health of Munitions Committee [illegible] draw conclusions from existing data, although the statistics published [illegible]

The Electrician.

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Electric Ploughing.

The present shortage of labour, coupled with the need for greatly increasing the land under cultivation, has given prominence to the advantages of mechanical ploughing. Although various methods have been suggested, and many have been actually tried, it is by no means easy to find one that is altogether ideal. Some of the difficulties are set forth in a Paper which has just been read by Mr. ARTHUR AMOS before the Institution of Mechanical Engineers. The great advantage of mchanical methods is that they enable the farmer to carry out his ploughing quickly when he considers the state of the soil is most suitable, instead of ploughing for long periods when the conditions are undesirable. This leads to a lower cost, and, owing to quicker operation, the land is kept in better condition.

On the other hand, there are a number of difficulties. Two schools of thought are at present noticeable. The first is that which relies upon the plough being drawn over the land by means of a steel rope. This is the method adopted in the well recognised steam plough, which has been familiar for many years. This type of plant, although no doubt efficient, is a costly investment, requiring skilled attention, and there are very few farmers who would care to make the necessary investment. The other school of thought relies upon some form of tractor considerably lighter than the steam-plough engine. In this case the tractor either draws the plough after it, or is combined with the plough and thus traverses the ground in carrying out the operation. Such tractors vary in weight from about 1 ton up to 5 tons. Unless the weight is beyond a certain figure difficulty is experienced in obtaining the necessary tractive effort. On the other hand, any considerable weight has the objection that it requires more power, and that it may be harmful to the soil, especially in wet weather; and not only so, but there may be difficulties in ploughing on hilly ground. Some of these objections may be eliminated by employing caterpillar wheels, but these do not obviate the damage completely, and they present the further difficulty that grit and dirt lead to considerable wear of the bearings and of working parts. Even tractors weighing 30 cwt. or less appear to be open to the objection of weight.

Any tractor has the further disadvantage that quite a considerable amount of land must be sacrificed at the end of each furrow. It appears that the length necessary for this purpose varies from 30 yds. to 50 yds. at each end, sometimes even more, so that a very considerable amount of time may be lost in this way. This difficulty is eliminated in the case of steam ploughing by using a balanced plough, and possibly this method might be adapted to light tractors, though it would present some complications.

There is obviously a good deal to be said in favour of using the power, as far as possible, merely for ploughing, thus eliminating the tractor—that is to say, by using some form of winch, which must be fixed either at both ends of the furrow with a reversing arrangement, or by having a continuous drive at one end of the furrow, with a suitable pulley at the other end, and some means of changing the plough from the "go" to the "return" rope in order to reverse its direction of motion when desired. There is no doubt that for that kind of arrangement the electric motor is extremely well adapted, and the problem resolves itself into a question of distribution rather than anything else. Fortunately, in this country the density of population is high; thus our towns are not far apart, so that there is a possibility of taking electric networks into many of our rural districts.

In this connection we might do well to bear in mind what has been done in Germany. In Mr. J. H. CAHILL's Report to the Board of Agriculture, published in 1913 (Cd. 6626), it is stated that electric ploughing is growing in favour and that the use of electricity by farmers is spreading rapidly in Germany through the medium of Agricultural Electricity Societies. At the time of the report the number of registered societies of this kind was estimated at 600 to 700. The object is to bring electric power within the reach of every farmer within certain districts.

In some parts of Great Britain, more particularly around Hereford, considerable progress has already been made in the use of electric power by farmers; but this has been in the direction of using stationary motors for driving various farm implements, such as chaff cutters, cream separators, &c. Electric ploughing is not such a simple matter. To start with, the power required is quite considerable, say 75 H.P. to 100 H.P., for the motor, and therefore it would be necessary to distribute at a pressure of 400 to 500 volts. Assuming that overhead lines are run near the fields where electric ploughing is to be carried out, there still remains the connection from these lines to the motor. It would be necessary to effect this by means of either portable overhead lines or by trailing cables, which latter are obviously undesirable. Nevertheless, a good deal has already been done, as will be seen by an article by Mr. A. DELAMARRE which we give on another page, and we feel that the subject should be considered seriously by all those to whom it is of interest. These include primarily the farmer; but it concerns no less the electric supply engineer, for there is no doubt that if electric ploughing became the recognised method in this country the energy so used would be quite considerable.

Review.

The Munition Workers' Handbook. By ERNEST PULL, A.M.I.Mech.E. (London: Crossby Lockwood & Son.) Pp. 158. 2s. 6d. net.

The second edition of this handy little book is a model of compression. It contains a couple of chapters devoted to workshop arithmetic, mensuration and geometry, followed by notes on materials and the heat treatment of metals. Subsequently there is a useful account of tools and mechanical processes, starting with an explanation of such simple tools as callipers, screw-gauges, scribing blocks, files, &c., and proceeding to lathes, drills, milling machines and screw-cutting. The application to munition-work is kept in mind throughout, and a special chapter is devoted to shell turning.

In the preface the book is stated to provide the practical information "a person taking up munition work would be required to know, in order to start work in an engineering shop." This may give the impression that considerable knowledge is necessary. Actually, many men and women have entered munitions works without any mechanical knowledge whatever, and yet have been able to do good service owing to the special dilution methods now practised. They should, therefore, not be deterred by the feeling of ignorance which this little volume may inspire.

But to anyone who has entered a shop and is anxious to increase his knowledge and rise from the level of mere routine work the book will be found extremely useful, the more so because it is in small bulk, capable of being easily slipped into the pocket, and suitable for reference at any moment.

The Utilisation of Manganese Ores in Sweden.*

By JOH. HARDEN.

I. The importance of manganese in the steel industry is so well known, that it would be idle to enter upon its merits in that respect. It is sufficient to repeat a well known Sheffield expression, saying "Manganese is the best tonic for a poor steel."

Sir Robert Hadfield in Sheffield has no doubt expanded our knowledge on this subject more than anybody else, especially as regards its physical influence upon the steel. The enormous number of tests carried out under his directions are far too many to be related here; they are recorded in the "Proceedings" of the Iron and Steel Institute, Met. and Chem. Eng., and elsewhere, and may be available for those interested.

The author then gives particulars of the resources of Sweden in manganese ores.

II. Methods of Smelting.

For the production of ferromanganese the ores pyrolusite (MnO_2) and manganese spar, ($MnCO_3$), are the chief materials. Pyrolusite has, theoretically, up to 63 per cent. of Mn and the spar 61·72 per cent. MnO. Other ores, such as braunite (Mn_2O_3), hausmannite $Mn_3(O_4)$, psilomelane, (MnO_2), and rhodonite, ($MnSiO_3$), are used with advantage. In some cases even manganese rich slags are being used.

Before the introduction of electric furnaces on a larger scale, it was the practice to smelt the manganese ore together with charcoal and iron ore in shaft furnaces, using a blast. In this manner Spiegel iron was obtained, containing from 5 to 20 per cent. manganese. Even in present days, a considerable quantity of high percentage ferromanganese is being produced in the blast furnace, especially in England and America; the loss of manganese is, however, very high, owing to the fact that the metal and its compounds are very volatile at high temperatures, and a great deal is carried away mechanically by the blast; also a good deal of re-oxidation is unavoidable.

It is on account of these facts that the electric smelting method has been widely adopted, and may, under otherwise suitable conditions, supersede the old method; this holds true especially in such countries like Sweden, because in that country the supply of ore is rather limited and charcoal is becoming more and more expensive every year, so that the greatest economy in both these directions is called for. The cost of power is, on the other hand, comparatively low, since power may be had for something like £2 per horse-power-year or less, when taken in bulk, and this feature alone would almost be sufficient for a decision in favour of the electric furnace.

In addition to this there is the fact that the material produced in the blast furnace has always a very high percentage of carbon, as a rule from 8 to 12 per cent., and a higher carbon content always calls for a lower price on the market. It is true, that a lower percentage of carbon may also be produced, by careful handling, in the shaft furnace, but in that case the losses are prohibitive, while in the electric furnace a product with lower carbon can be obtained at will without any excessive loss of material.

In the practice also, a considerable quantity of other manganese alloys, besides ferro alloys, is in demand, and these can hardly be produced economically, if at all, except in the electric furnace.

III. Furnace Type.

As to furnaces, either single-phase furnaces with conductive hearth, or three-phase furnaces with or without the neutral point at the bottom, may be equally advantageously used. When working on a large scale, the latter type, with the neutral point under the hearth, seems, however, to be mostly preferred, for many reasons. The electrodes become smaller, the heat distribution in the furnace is more uniform, and the power [illegible]. Also the tapping is less troublesome.

It is fortunate that the ferromanganese has a comparatively low smelting point, from [illegible] to [illegible] C. (depending on the grade), so that it may, unlike ferrosilicon, for example, be easily run off into moulds and a larger piece [illegible].

The furnace is charged with [illegible]

readily if the iron is added in the metallic state, than if ore is added; hence there is a saving in material.

Lime, quartz, &c., should also be added in so far as the individual ores require it to ensure good working.

The consumption of power depends on the following three factors, namely: The size of the furnace, the proper handling of the charge and operations; finally, on the desired percentage of carbon and silicon.

As a basis for estimation, however, it may be assumed that a furnace with a capacity of, say, 3,000 kw., three-phase, properly managed, should not consume more than 8,000 to 8,500 kw.-hours per ton of ferromanganese under normal conditions.

The furnace should be worked so *that no open arc* will occur, otherwise great losses and a higher power consumption per ton will result. The charge must be kept so high in the furnace that the actual working zone is fully covered and the incandescent part of the electrodes nearly buried under the charge. The tappings must be timed with great care, and overheating of the metal must be studiously avoided; any mistake in these directions will inevitably result in bad economy.

The manganese easily forms double carbides of manganese and iron. The manganese carbide proper, CMn_3, holds, theoretically, 6·77 per cent. C. and 93·23 per cent. Mn. Ferromanganese, as produced in the electric furnace, will, as a rule, hold about 6–8 or 10·5 per cent. C, depending on the manner of working. A typical analysis of the market product is:—

Mn = 80·60	per cent.
Fe = 11·93	„
C = 6·41	„
Si = 0·65	„
P = 0·08	„
S = 0·026	„

A low content of Si as well as C is always desirable. A much lower percentage than the one given above, down to 2 per cent. and even under 1 per cent. *can* be obtained with proper working of the furnace; should, however, such a low carbon be called for, it will, as a rule, be found much too uneconomical to produce it in one operation, and far better to refine the product in a subsequent treatment. This operation is a rather difficult one and, of course, necessitates a larger power expenditure; hence the higher price for such material.

In the case of silicomanganese a suitable quantity of quartz is added to the charge, allowing for the amount of silicon which is usually volatilised as well; the finished product holds generally about 70 per cent. Mn, 18–20 per cent. Si, and 6 per cent. C.

A few special steels require an alloy particularly high in Mn, up to 98–99 per cent. Such material is usually produced by the thermite process, in which finely divided aluminium is used as a reducing agent. In this way, an alloy very high in Mn and low in carbon is obtained, but the product is also very expensive, on account of the high price of the aluminium. Also, although the method is very simple, it cannot be used on a large scale, as is obvious.

It is also possible to produce pure Mn by means of electrolysis of the molten oxide in a fluorspar bath; according to [illegible] in France, only 3,475 kw.-hours per ton of manganese would be required.

All such methods, however, [illegible] on account of low efficiency and high cost of power.

IV. Methods of [illegible]

[illegible]

* [illegible] June [illegible], 1917. [illegible]

the mass, leaving a trail much like a "comet's tail" of manganese behind itself.

If such an ingot is cut into two along its length after it has cooled down, it will be observed that these lumps form light spots, more or less prominent as hard lenses in the steel. If the ingot is rolled out, these lenses elongate, forming the well-known "ghost-lines," so called because they sometimes disappear and again turn up elsewhere. Such ghost-lines are recognised to be very detrimental to the steel.

The only correct way to avoid such chances is, therefore, to add the ferromanganese in a *liquid state* at the *right moment* direct into the liquid steel in the ladle and stir properly. This method does not, of course, apply to crucible steel, where the alloying takes place under entirely different conditions.

In order to add the alloy in the molten state, the electric furnace was adopted. For instance, at Messrs. Roechling's works, where the author had several opportunities of following the process closely as regards economy and utility, the pig-iron was drawn direct from the blast furnace and teemed direct into the Bessemer convertor, where it was blown down for about seven minutes. It was then tapped into a ladle, the right amount of ferromanganese, previously melted in a suitable electric furnace, was added, and a part of the charge was brought into an induction furnace and finished off as high grade steel, while another part was treated elsewhere as lower grade of steel for rails, &c. As this procedure was repeated as often as every other hour, and about 120 lbs. to 140 lbs. of ferro was added each time, it was necessary to provide for a suitable stock furnace for molten ferromanganese alone, the furnace being always ready to deliver the adequate quantity of metal required.

A furnace specially suited for this purpose must be so designed that a very even supply of heat is provided, without the danger of accidental overheating or breakdown, which would lead to loss of material and disturbance of the whole subsequent routine. Oil furnaces have been used for the purpose with success, but especially in Scandinavia the demand on oil cannot be met, for obvious reasons. Besides, the oil furnace requires a blast, the air being in excess, in order to obtain the temperature required, and this leads to oxidation [illegible]

The electric furnace is therefore, especially in the countries mentioned, the most appropriate form of heating device, particularly if worked with indirect arc, or, better still, as an induction furnace. The latter type is doubtless more economical as far as heat efficiency goes, although the lining question may be more difficult to handle, inasmuch as the manganese, as is well known, possesses special cutting properties for linings. This difficulty can, however, be satisfactorily solved by the choice of the right material and proper handling.

[illegible] three-phase induction [illegible] which gave very [illegible] one. At another [illegible] somewhat similar to the [illegible] the Nathusius type was used in another instance, as described later, and worked satisfactorily.

[illegible] "Stahl & Eisen," [illegible] on the spot. The [illegible] tons respectively, [illegible] but is the result [illegible] account. The [illegible] and 120 kw. for [illegible]

In order to obtain reliable figures of the heat balance, the average [illegible] For the [illegible] Mn, 11·93 per cent. [illegible] The results of these observations [illegible] Tables I. and II.

[illegible]

Table I.—*Specific Heat of Ferromanganese.*

Temperature C°.	Average specific heat.	Calories absorbed by 1 gr. FeMn.
600	0·1625	97·5
700	0·1667	116·7
800	0·1711	136·8
900	0·1763	158·6
1,000	0·1822	182·2
1,060	0 1863	197·4
1,200	0·2133	255·9
1,258	0·2225	280·0
1,340	0·2268	304·0

Table II.—*Heat Balance per Ton of Ferromanganese.*

Heat Supplied.	Kw. hours.	Per cent.	Heat Expenditure.	Kw. hours.	Per cent.
Electric energy supplied	833	100	Re-melting heat	354·0	42·5
			Melting of the slag	7·4	0·9
			Losses:—		
			Transformer	33·3	4·0
			Leads	58·3	7·0
			Cooling water..........	50·0	6·0
			Radiation and conversion losses	330·0	39·6
—	833	100	—	833·0	100·0

The costs of operating the arc furnace for ferromanganese are given as follows, the cost of power being approximately 0·24d. per kw. hour :—

Cost per ton of Ferromanganese.	Shillings.
Power : 833 kw. hours at 0·02 shilling per kw. hour	16·66
Electrodes, at 35s. per 100 kg.	= 1·90
Labour costs	= 1·65
Linings and repairs	0·65
	20·86

or in round figures, £1 0s. 10d. per ton of ferromanganese. This does not include the energy for the preliminary heating-up.

The corresponding figures for the induction furnace show about the same result, or a little less, namely 19s. 3d. per ton. As the electrode item is eliminated, the costs should be less, but the maintenance of the lining cost a little more; hence the lesser difference in the sum total.

The cost of heating up of the arc furnace from the cold is as [illegible]:

	Shillings.
Power : 630 kw. hours at 0·02 shilling per kw. hour	12·60
Coke and electrodes..	5·50
Labour..	2·10
	20·20

or just over £1.

The heating up of the induction furnace costs 17s. 6d.

The loss of manganese was in both cases very slight, being 0·385 per cent. in the electrode furnace and 0·360 per cent. in the induction furnace, and is thus negligible.

Comparative tests showed a saving of 44·3 per cent. in ferromanganese by adding it in the liquid form as compared with the solid pre-heated in an oven.

Apart from the superior product there is a saving in time which should not be overlooked; if liquid alloy is really at hand, it is [illegible] that the finishing off of a charge is effected much more rapidly and certainly than if solid material is added, and this is of no small importance in increasing the total efficiency of the plant.

[illegible] all, it seems as if the electric furnace has one of its [illegible] in this direction at present, as no other furnace is so [illegible] to this task and the immediate result is certain. Of [illegible], the prejudice of works managers and workmen alike must [illegible] overcome, and, we fear, this is the most difficult aspect. [illegible] to design a serviceable furnace than to persuade [illegible] and to handle it properly.

Books Received.

[illegible] can be had from THE ELECTRICIAN Offices, on [illegible] postage.]

[illegible] Longmans. [illegible]

[illegible]

A Constant Torque Clutch.

Last week we had an opportunity of witnessing at Faraday House the action of a new magnetic clutch in driving a dynamo used for electric welding. The clutch consists essentially of a differential electromagnetic coupling, which acts as a kind of mechanical overload release and has therefore a number of special applications in cases where constant current or constant torque are desirable.

The clutch, which is due to Mr. W. Langdon Davies, has been

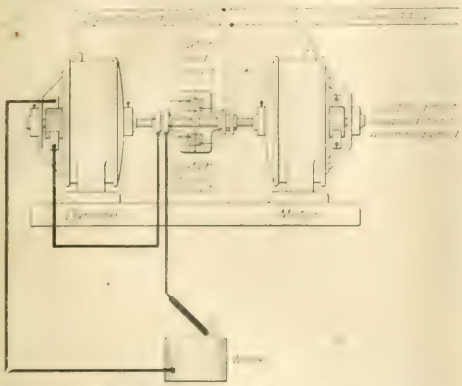

FIG. 1.—DIAGRAM OF CONNECTIONS.

patented for controlling either (a) the electrical output of a dynamo or (b) the mechanical output of a motor.

The general arrangement is shown in Fig. 1, illustrating its application to a motor generator suitable for electric arc welding.

Fig. 2 shows the complete electrical [illegible] of the clutch, the clutch itself being shown diagrammatically. There are three coils, A, B and C. A and C consist of many turns of fine wire, while B is a series coil consisting of a few turns of thick wire. The action

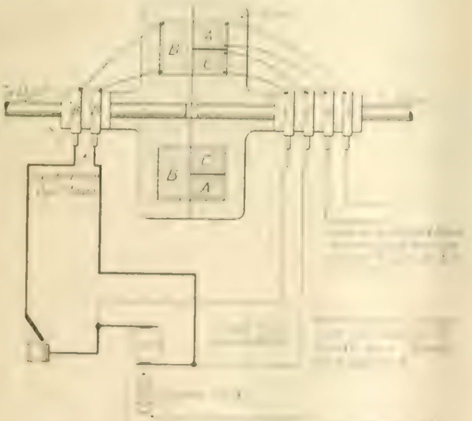

FIG. 2.—DIAGRAM OF CLUTCH.

[illegible]

current taken from the dynamo, therefore, cannot pass a certain maximum, which is adjustable by varying the excitation of coil A with a rheostat. In Fig. 4, Curves AFO shows the characteristics of a separately excited dynamo when only coils A and B are used.

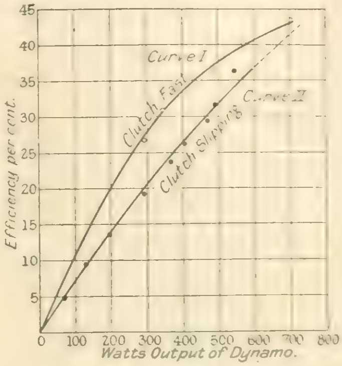

FIG. 3.—EFFICIENCY CURVES.

[illegible]

The current rises and then falls, owing to the slip of the clutch; which begins at F, increasing. This fall is caused mainly by the drop in the coefficient of friction [illegible] the clutch would [illegible]

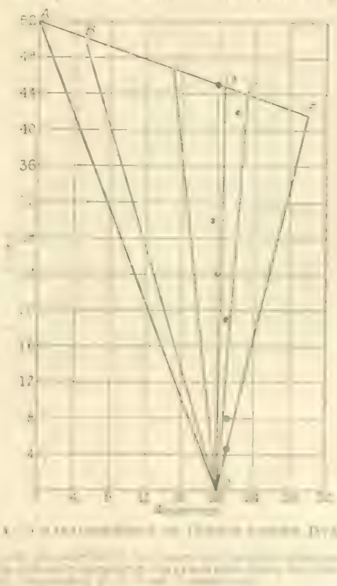

FIG. 4.—CHARACTERISTICS OF [illegible] DYNAMO.

[illegible]

decrease, thus diminishing the effect of coil C, which is equivalent to increasing the effect of coil A. By this means the slip is prevented from increasing unduly, and as a result of the action of the three coils the pressure is adjusted so that the current remains practically constant. By suitably proportioning the coils A and C the characteristics may be varied between the limits shown in Fig. 4. A cross-section of the actual clutch is seen in Fig. 5, while Fig. 6 is a view of the set which was exhibited at Faraday House. In the drawing of the clutch it will be noticed that care has been taken to enable the keeper to adjust itself to the pole face of the clutch.

Among the applications of the device may be mentioned (1) electric arc welding, (2) battery charging and (3) as a coupling in motor generator sets, *e.g.*, those used for tramway supply. In these cases constant current is very desirable. No resistance whatever is introduced into the welding circuit, so that the whole of the watts generated are available for the work. The work of welding, however, is facilitated by inserting inductance in the circuit. In motor generator sets the clutch is an advantage in that it affords complete protection against short-circuits on the line, protection by ordinary cut-outs being unnecessary. In battery charging the current is automatically limited to a given value.

The clutch can also be used as a hand-operated device.

The chief difficulty met with in designing electromagnetic friction clutches for such a purpose is due to the residual magnetism. This residual magnetism may be over 50 per cent. and prevents the clutch releasing when the current is reduced or switched off.

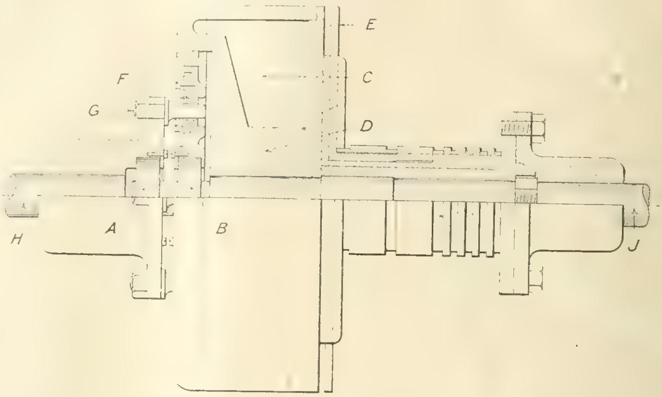

FIG. 5.—SECTION OF CLUTCH. (Scale 1:5.)

A, F, [illegible] of shaft; B, allows the keeper to adjust itself to the [illegible] C, [illegible] D, Magnetic circuit. E, Connector to slip ring from the [illegible] B [illegible] F, L[illegible] G, [illegible] H, Dynamo shaft. J, Motor shaft.

The better the magnetic circuit of the clutch and therefore the smaller the consumption of electrical energy required to work it, the higher is the percentage of residual magnetism. To overcome this difficulty it has been customary to put a gap in the magnetic circuit, that is, to make a comparatively bad magnetic circuit; or to provide a spring sufficiently strong to pull the clutch apart when the electric current is broken. The former entails a larger clutch, and [illegible] seriously compromise the regulation, the latter makes it impossible for the current to pick up or release the load gradually, due to the fact that [illegible] the current is sufficiently energised to overcome the spring it engages with a jerk.

In the present clutch the magnetic circuit has been made as compact as possible, so much so that it will transmit 1,000 watts of electrical energy with a consumption of less than 1 watt, *i.e.*, one-tenth per cent. loss. The residual magnetism of the clutch is over 60 per cent., but owing to the special method of operating it, this residual magnetism is completely swept out on releasing the clutch, and it may be operated at any degree of slip and any load, gradually, [illegible] between zero and full load.

In the case of a good magnetic circuit, the clutch may be arranged, if desired, to be energised to a higher density than that required to transmit the load, in which case the current can be broken altogether when the clutch is transmitting full load, the residual magnetism being sufficient to carry the load, and the clutch then works without any consumption of energy, the current being only employed to pick up or release the load.

Control of a clutch in such a case is effected by exciting the C coil from a small battery. This battery is connected up to diametrically opposite points of a closed circular resistance, so that current flows round the two halves of the resistance in parallel. Current for the C coil is tapped from this resistance by means of two sliding brushes at the opposite ends of a diameter. It is clear that if these brushes are so placed as to be in contact with the points where the coil is fed by the battery, the maximum current will be received by the coil, whereas if they are moved round to a position at right angles, *i.e.*, to a position where the brushes are at equipotential points, no current will be supplied; and if the brushes are moved still further, the current will be reversed. Consequently, if it is desired to release the clutch from full load, the brushes are moved round until the current is reversed sufficiently to sweep out all the residual magnetism. In a device of this kind the power consumption in the clutch coil and resistance amounts to about 2 watts per 1,000 watts transmitted.

FIG. 6.—VIEW OF [illegible]

On the occasion of our visit the clutch gave excellent regulation, the current being maintained practically constant (at a value depending on the setting) for various voltages down to short-circuit. It was noticeable that the clutch responded very quickly. A certain amount of heat is, of course, generated at the clutch surfaces, but in this connection it must be borne in mind that the device is not designed for continuous slipping, but only for slipping at intervals when necessity for regulation arises.

Electrical Industrial Development in Switzerland.—The "Bulletin" of the Swiss Electrical Union for December, 1917, contains a report by Dr. E. Tissot on the Swiss electrotechnical industry which contains some interesting data. The export of electrical energy from Switzerland by October, 1917, had reached a considerable total, France and Italy receiving [illegible] H.P. and Germany 53,617 H.P. Electrometallurgical products have made great strides during the war, the value of the export of aluminium in 1916 being nearly four times what it was in 1912 and 1913. Of this, by far the greater part went to Germany. The same applies to calcium carbide and ferro-silicon, the value of the export of these commodities having nearly doubled since the war began. On the other hand the export of electrical machinery to Germany seems to have diminished, the data both for Brown, Boveri & Co. and Escher Wyss & Co. showing steadily diminishing exports to that country in the years 1913-1917.

After-War Problems.

WORK FOR NATIONAL TRADE COUNCILS.

The Lord Mayor presided at Wednesday night's lecture of the Bristol Reconstruction Association, and alluded to the interesting and instructive nature of the addresses hitherto delivered. Mr. E. J. P. Benn, who was to speak to them that evening, had taken a prominent position in reconstruction questions, and was Chairman of the Industrial Reconstruction Council of London.

Mr. Benn prefaced his lecture by expressing the belief that the Bristol Association would become historic, for Bristol had taken a lead in a movement which must spread throughout the land and which was full of hope for the industrial future. His subject was "The Higher Direction of Industry." Why was a higher control necessary? There were people who had learned nothing from the war, who looked to the end of the war as a glorious day when they could go back to the habits and customs of 1914. It was easy to show that the 1914 standard would not suffice for future needs. They were then raising a national revenue of £200,000,000. If the war stopped to-morrow the Government would find it necessary to raise three times that sum. There was only one way in which that demand could be met—increased production—and 1914 methods would not give the large increase that would have become a national necessity. The standard of living had been raised and that would not be let go. That, too, would demand larger production. There was no successful church based on the idea that the salvation of the individual depended on the damnation of his neighbours, but an idea much of that character had been prevalent in trade. Traders, however, were beginning to see that a prosperous competition was an asset; that a well-paid body of workmen was a necessity; a successful employer a *sine qua non*, and that there was an entity, an organism, which they called a trade, the well-being of which it would be the duty of everyone engaged in the trade to promote. He wished to put two questions: (1) Whose duty is it to look after the trade? and (2) Assuming direction is necessary, what does that higher control involve? The first he would leave unanswered, except to say he assumed there would be established a Whitley Council in each trade, or some body representing the whole trade—every section of it. With regard to the second question he would say more. The Whitley Council must be debarred from doing work that could be done by an individual; it must do nothing to interfere, within well-defined limits, with the liberty of the individual to carry on business in his own way. It must do nothing that could be done by a sectional organisation of the trade. The Council must confine itself to work no one was doing at present. There were half a dozen questions urgently awaiting the attention of these trade parliaments. One, for which Mr. T. B. Johnston was responsible—the National Council for the Pottery Trade—had set an example to the rest of the industrial world, and the Ministry of Reconstruction hoped there would be similar institutions in every trade, so that they might set to work upon these questions. One big question concerned their attitude to the mass of restrictions imposed by the succession of Government Orders since the war. Sweep them away, someone would say. But that might involve ruin. They would have to consider the immensely difficult problem which of the Orders it was desirable to retain for a little while. There was the question of rationing in regard to raw material. There was the pledge to restore after the war every Trade Union condition. It was a pledge from which no one desired to depart, but both sides knew that conditions had completely altered, and the pledge must be reconsidered by both sides. There was the ghastly problem of demobilisation. The plans for the demobilisation [illegible] could be made by the trade itself. [illegible]

[illegible]

Correspondence.

"ELECTRIC TRACTION."

TO THE EDITOR OF THE ELECTRICIAN.

Sir: With reference to the [illegible] of the above in the current number of The Electrician, I should like to reply to two points raised by Mr. Carter.

1. The double catenary type of overhead construction was discussed because it has been adopted on an extensive scale for the suburban lines of the Brighton Railway, and forms the most extensive example of railway overhead construction in this country.

2. Chapters XVIII. and XIX., dealing respectively with train resistance and train movement, were separated from the preliminary chapters on this subject for the following reasons:—

(*a*) The author's teaching experience has convinced him that dynamics of train movement must be treated *before* other details of the train equipment (*e.g.*, motors and control).

(*b*) The detailed consideration of train movement and the calculation of energy consumption cannot be taken up satisfactorily until the train equipment, rolling stock and train resistance have been considered.

(*c*) Train movement is associated with the subjects of train equipment, rolling stock and train resistance rather than those of trackwork, feeders and sub-stations.

I may mention that the book was prepared for the student and the engineer who is not a specialist in railway matters. For this reason the subject of "control" was treated extensively and some of the older methods were included in order to lead up to the modern [illegible] control systems.—I am, &c.,

London, Jan. 21. A. T. Dover.

FACTORY ELECTRIFICATION.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I regret having again to trespass on your valuable space. Mr. R. L. Gass, in his letter published in your last issue, assumed quite correctly that my "knowledge of the interior reasons for the adoption of the scheme is nil," but the logic of his following remark, "[illegible] of much value" is at fault.

Unfortunately, Mr. Gass has adopted a [illegible] in dealing with my letter instead of giving the information for which I asked. Obviously it was [illegible] direct from the Corporation at [illegible] volts; otherwise why install motor generators at all?

Allow me briefly to detail the plant installed, which was as follows:—

[illegible]

[illegible] 300 revs. per min.

[illegible] per min.

[illegible]

[illegible]

Immediate scrap value of all the existing direct current generators (probably much higher now than two or three years hence.)

Decreased running costs due to higher efficiency.

Decreased maintenance costs.

From Mr. Gass's remarks apparently the motors of the 200 kw. sets could be used later on, and the generators would be disposed of.

Mr. Gass knows very well that the variation of the load from 5 to 100 per cent. (quite usual) is no justification for the installation of seven sets; if a small set to deal with long periods of light load is necessary then let it be installed. The determining factor is, of course, the average working load, and with three sets, as suggested, there should be ample margin for economical working. The C.W.S. is, indeed, fortunate in having so much floor space, but I should have thought the saving of about one half, which would be effected if the three sets I have suggested were installed, could have been put to some useful purpose, but there again "my knowledge, &c., &c., is nil."

Assuming that a very small set would be installed to take care of the small load required over long periods, if such is necessary, the question of efficiency resolves itself into a balance of efficiencies at the average load during working hours, which, undoubtedly, would result in not less than 5 per cent. of the total units consumed in favour of my proposal, and this might easily be equivalent to 50,000 units per annum, which, at 0·75d. per unit, is, say, £150 per annum—quite an appreciable amount. I note Mr. Gass does not propose to enlighten me on this interesting point. Why?

To cite the C.W.S. sub-station with its very low speed sets as an "excellent example of modern practice," is surely, in view of what I have mentioned above, somewhat wide of the mark, and is it not rather a museum of interesting, antiquated, [illegible] machinery? I am, &c.,

Enfield, Jan. 10. E. W. DOREY.

THE 12½ PER CENT. BONUS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: A state of doubt seems to prevail in regard to the application of Sir George Askwith's decision. A consideration of its origin, however, lends a principle of guidance.

The award was given primarily under the Munitions of War Act, 1916, this Act covering all electric supply undertakings which are certified by the Minister of Munitions. The award [illegible] is to be construed as universal throughout the country in so far as above undertakings are concerned.

The consideration of the case, of course, excludes undertakings not certified by the M. of M. and not parties to any agreement. I am, &c.,

[illegible], London, Jan. 23. T. W. COLE.

[It would appear that all electricity undertakings, whether certified or not, are included in the Award.—ED. *E.*]

Board of Trade Reorganisation.

A memorandum has been issued for the purpose of explaining the scheme for the reorganisation of the Board of Trade.

[illegible]

istrative functions of a permanent nature with regard to trade and transport now or in the future entrusted to the Board. It will, therefore, include the work performed by the present Marine, Railway, Harbour, Companies and Bankruptcy Departments.

Each of the two main Departments will be in the charge of a Joint Permanent Secretary, but the Permanent Secretary in charge of the Department of Commerce and Industry will rank as senior. One of the Assistant Secretaries in each main Department will be of senior status to the others, with a view to giving direct assistance to the Permanent Secretary in the general work of the Department. To determine questions of policy arising in either Department or affecting both, the President and the Permanent and Parliamentary Secretaries will meet regularly and will thus constitute an effective working Board.

DEPARTMENT OF COMMERCE AND INDUSTRY.

The Department of Commerce and Industry will be concerned with a variety of matters, and will be sub-divided into sections, each in the charge of an officer of Assistant Secretary rank, but the organisation will be kept as flexible as possible, and the heads of the various sections will be in constant consultation with each other, and so far as possible will be interchangeable. The heads of departments will make frequent visits to the chief centres of commerce and industry at home and abroad to widen their knowledge. The proposed sections of the Department of Commerce and Industry will at the outset be as follows:—

(*a*) *Commercial Relations and Treaties* (present Commercial Department) including such matters as commercial treaties and agreements, Empire and foreign tariffs and trade regulations, and all other matters within the scope of the Board of Trade which involve representations to or negotiations with Governments within the Empire or foreign Governments relating to the protection and furtherance of British commercial and shipping interests in the Empire and in foreign countries.

(*b*) *Overseas Trade* (*Development and Intelligence*). (Joint Department of Board of Trade and Foreign Office.)—The functions of the Board of Trade with respect to commercial intelligence and overseas trade development, including the control of the Trade Commissioner Service and relations with the Commercial Attaché and Consular Services, will be exercised through the new joint Department of the Board of Trade and Foreign Office. The Department will also carry on the work of the late Exhibitions branch of the Board of Trade.

(*c*) *Industries and Manufactures.*—A new department dealing with home industries, with special reference to their development and stability, production, and the economic strength of the country generally; with questions of policy connected with trade monopolies and combinations, alien penetration into British industries, and the promotion of new trades. This section will deal also with matters relating to reconstruction of British industries and trades.

(*d*) *Industrial Property.*—The main part of this Department will be constituted by the existing Patent Office, but the Department will not only administer the law relating to patents, designs, trade marks, and copyright, but will also be charged with dealing with all branches of industrial property from the point of view of commercial and industrial policy, including both the encouragement of invention and the protection of the commercial public from the abuse of monopoly.

(*e*) *Industrial Power and Transport.*—A new Department charged with the consideration of all questions of general policy relating to transport in its commercial aspect, including shipping, canal and railway rates and facilities, through railway and ocean rates, shipping conferences, &c. It will also deal with questions of policy relating to industrial power, including electricity, gas and water power for industrial purposes, the conservation of fuel, &c.

(*f*) *Statistics.*—This department will combine the work of the present Census of Production Office with a centralisation and consolidation of the work of collecting and classifying statistical returns at present carried out by various sections of the Board of Trade. It will deal with British and foreign import and export returns, and with the statistics of shipping, railways, wholesale prices, emigration and immigration, output of industrial establishments, &c.

(*g*) *General Economic Department.*—A new and important section will be created under this title to assist the Permanent Secretary in relation to questions involving economic policy, especially those which, owing to their generality or novelty, extend beyond the sphere of any special department. The new section will take over any of the duties of the "Commercial and Industrial (War Inquiries) Branch" of the Board of Trade which are not transferred to the statistical department.

There will be a strong Advisory Council attached to the Department of Commerce and Industry thoroughly representative of the commercial and manufacturing interests of the country. This Council will be divided into sub-committees meeting at frequent intervals.

PUBLIC SERVICES ADMINISTRATION.

[illegible] and re-groupings will be necessary in the case of the [illegible] of the branches of the Board of Trade which fall within the Department of Public Services Administration. The backbone of the work of the Department will be the administration of a number of important [illegible], such as the Railway Regulation Acts, the Merchant Shipping Acts, the General Harbour Acts, the Gas and Water Acts, the Electric Lighting Acts, the Companies Acts, the Bankruptcy Act, the Weights and Measures Acts, &c. In addition, this Department will deal with [illegible] of the [illegible] railways, shipping, harbours, electric [illegible], &c., considered as undertakings, while, generally, the Department of Industrial Power and Transport will deal with the [illegible] out of the relation of these undertakings [illegible]

Heads of Departments

The Joint Permanent Secretaries are: (1) Sir H. Llewellyn Smith, K.C.B.; (2) Sir W. F. M[illegible], K.C.B. (7, Whitehall-gardens, S.W. 1).

A.—Department of Commerce and Industry (Sir H. Llewellyn Smith).

Commercial Relations and Treaties.—[illegible] (Asst. Sec.) (Gwydyr House, Whitehall, S.W. 1).

Overseas Trade (Development and Intelligence) (Joint Dept. with Foreign Office.)—Sir W. H. Clark, K.C.S.I., C.M.G. (Comptroller General) (73, Basinghall-street, E.C. 2).

Industries and Manufactures.—Percy Ashley (Asst. Sec.) (Gwydyr House, Whitehall, S.W. 1).

Industrial Property (including Patent Office).—W. Temple Franks, C.B. (Comptroller General of Patents, Designs, and Trade Marks) (25, Southampton-buildings, Chancery-lane, W.C. 2).

Industrial Power and Transport.—H. F. Carlill (Asst. Sec.) (Gwydyr House, Whitehall, S.W. 1).

Statistics.—A. W. Flux (Asst. Sec.) (68, Victoria-street, S.W. 1).

General Economic Department.—S. J. Chapman, C.B.E. (Asst. Sec. (Gwydyr House, Whitehall, S.W. 1).

B.—Department of Public Services Administration (Sir W. F. Marwood).

Marine.—C. Hipwood, C.B. (Asst. Sec.) (7, Whitehall-gardens, S.W. 1).

Public Utilities and Harbours.—[illegible] (Asst. Sec.) (7, Whitehall-gardens, S.W. 1).

Railways.—[illegible] (Asst. Sec.) (7, Whitehall-gardens, S.W. 1).

Companies.—H. A. Payne, C.B. (Comptroller) (55, Whitehall, S.W. 1).

Bankruptcy.—J. G. Willis, C.B. (Inspector-General in Bankruptcy) (1, Horse Guards-avenue, S.W. 1).

Legal Intelligence.

The Kensington & Knightsbridge and Notting Hill Companies Arbitration.

On Friday last Mr. Justice [illegible] gave his reserved judgment in the case [illegible] argued before him in which the parties were the Kensington & Knightsbridge Electric Lighting Co. and the Notting Hill Electric Lighting Co., the latter company appealing against an award of Mr. Jas. Swinburne. [illegible] of Dec. 28.

In giving judgment his Lordship said the points at issue between the [illegible] Mr. James Swinburne. He would refer to the Kensington Company as the plaintiffs and to the Notting Hill Company as the defendants. Mr. Swinburne had awarded damages to plaintiffs for breach of contract by defendants. The primary question was the construction of a short [illegible] Oct. 25, 1900. [illegible] two companies shall from time to time take from the joint station all [illegible] sources of supply) may require for the purposes of its business in accordance with the provisions of the principal agreement, or such other pro[illegible] carried out its statutory rights and duties. In order to meet the ever-[illegible] principal agreement). The substance of the bargain was as follows: (a) [illegible]

companies "may respectively distribute the energy in such proportions and manner as the two companies may from time to time determine for the purpose of supply within their respective areas of supply as for the time being authorised or for giving effect to any agreement made under the provisions of this Act." Shortly after the passing of the above Act the companies entered into a further agreement jointly with the trustees of certain debenture stock, through the issue of which the new undertaking was to be financed. The agreement was dated Oct. 25, 1900, and clause 4 provided (in essence) that the two companies should pay in the manner and proportions provided by the principal agreement all the expenses of working the joint station at Wood Green. By their provisional order of 1889 defendants were expressly prohibited from supplying energy or laying down any electric lines or works beyond their area of supply, otherwise than under the authority of Parliament or under a licence granted by the Board of Trade. The existing area of supply was indicated clearly by the red colouring on the deposited map. Adjacent to, but in fact outside, the area of supply of the defendants was a district called Kensal Town. To consumers within that district defendants supplied energy in 1909. They bona fide (but erroneously) believed that such consumers were actually within their statutory supply area. But they did not procure such energy either from the joint station or their own generating sources; they obtained it from a wholly separate source, and supplied it at a profit to the Kensal Town consumers. Plaintiffs contend that a breach of contract was thereby committed by defendants. The arbitrator had held that the contention was well founded, and in respect of such breach he had awarded £189 damages. Defendants, however, submit that their acts do not constitute a breach of clause 3 of the agreement of 1900.

In order to appreciate the point it was necessary to say that on Nov. 25, 1909, the Electric Lighting Act, 1909, was passed. By sec. 6 of that Act the Board of Trade was empowered to grant licences whereby an undertaker could supply electricity to consumers outside his actual statutory area of supply. It was reasonably clear from the various sub-sections of section 6 that the effect of a licence was not to extend an undertaker's statutory area of supply. It would operate only as a valid authority to supply electricity (in specially permitted cases) to consumers outside the statutory area. The actual statutory area, with its special features of rights and duties, remained untouched. In respect of the abovementioned supply to Kensal Town consumers in 1909, no fringe order had been granted. Defendants, therefore, were acting *ultra vires* in giving the supply; but in the years subsequent to 1909 "fringe orders" were duly granted by the Board of Trade, whereby defendants were authorised to supply electricity to various consumers in Kensal Town. Thereupon they supplied electrical energy to such consumers; but they procured it, not from the joint station, but from a wholly separate source, and supplied it to such consumers. Plaintiffs contended that a further breach of contract was thereby committed by defendants. The arbitrator had held that such contention was correct, and in respect of such breach he had awarded £1,661 damages. The determination of those two heads of dispute depended upon the true construction of clause 3 of the agreement of 1900. The clause was difficult to construe. The vital words which appeared in it were loose in meaning and elastic in significance. He would consider first of all the word "require" which preceded the words "for the purposes of its business." He had considered clause 3 of the agreement of 1900 in the light of the Act of 1899, which authorised the erection of the joint station and of the general provisions of the principal agreement of July 12, 1899. Having regard to the scheme indicated by such documents, he was clearly of opinion that the word "require" bore the meaning given to that word by the House of Lords in the Kimberley and De Beers case rather than the meaning given by the same [illegible] v. Attorney-General. Hence, he thought that defendants were *prima facie* bound to take from the joint station all the electricity in fact needed for its business beyond the [illegible] On the meaning of the word "business" the great body of argument turned [illegible] Mr. T[illegible] the word "business" meant [illegible] Mr. Knox submitted that the word "business" was not so limited, but that it embraced the totality of supply by defendants not only within their statutory area but also outside it. The word "[illegible]" was essentially vague. It was a word easy to employ but difficult to define. It [illegible] The word "business" [illegible]

Trade. But defendants contended that such meaning could not be yielded to such word in view of the relevant statutory provision in the earlier agreement and the circumstances of the case, and that he must limit the meaning to the supply of electricity to defendants' statutory area. Upon the whole, though with much doubt and not without regret, he felt that he must accede to that contention of defendants.

The agreement could not be construed apart from the General Act of 1899, from which alone its efficacy was derived. Both the agreement of 1899 and that of 1900 depended for their juristic vitality upon the statute. But for that Act they would be printed vanities only. Nor could the agreement of 1900 be construed apart from the provisions of the earlier agreement of 1899. The two agreements were special contracts made for a special purpose under the authority of a particular Act of Parliament. The apparent generality of words in such agreements must be limited by the circumstances of the case. It was a sound rule of law that a document should receive, so far as possible, such an interpretation as would confine the scope of the bargain to acts which might lawfully be done. A meaning which involves either a breach of the rules of public policy or a violation of the rule of *ultra vires* should not be given unless called for by the plain meaning of unambiguous terms. It would be convenient to consider separately (*a*) the supply to consumers by defendants under the fringe orders granted by the Board of Trade, and (*b*) the supply by defendants to outside consumers in 1899 without lawful authority. The agreement of 1900 was merely supplemental to the agreement of July, 1899. The latter agreement recited in the clearest manner that the joint station was to be used by the companies for the purpose of their respective undertakings. In view of sections 1, 2 and 3 of the Electric Lighting Act, 1882, he thought that the word "undertaking" meant (in the absence of enacting provision to the contrary) the supply of electricity to the specifically authorised statutory area. His Lordship pointed out that in 1900 "fringe orders" were quite unknown. They did not spring into existence until 9 years later, when the Act of 1890 was passed. By sec. 2 of such Act fringe orders were authorised for the first time. As to "*ultra vires*," it was not necessary to discuss the various meanings of the words. In the present case the doctrine of *ultra vires* was not to be applied in its usual meaning. For the agreement of 1900, even though construed in the widest manner, would be within the juristic capacity of both plaintiffs and defendants. Their respective memoranda gave them the broadest powers. The doctrine was to be applied with respect to a specific statutory venture—namely, the provision of the generating station under the Joint Act of 1899. The agreements between the parties gained their legal validity from such Act. Hence, it followed that the agreements could go beyond that which was permitted by the enabling statute. If the Joint Act of 1899 be looked at, it would be seen that the recitals dealt in the clearest manner with the specific areas of the supply of the two companies, and with such areas only. The whole purpose of the Act appeared to be the increase of supply to those specific areas. Then sec. 5, which gave the power to erect the joint station and plant, and to generate and distribute electricity, provided that the companies might "respectively distribute such energy in such proportions and manner as the two companies may from time to time determine for the purpose of supply within their respective areas of [illegible] or for giving effect to any agreements made under the provisions of this Act." The latter words—"or for giving effect to any agreement made under the provisions of this [illegible] 22, and did not touch [illegible] the plaintiffs and [illegible] with respect [illegible] the electric energy [illegible]ted at such station. Such distribution must, he thought, be in [illegible] He was satisfied that [illegible] energy generated [illegible] within the [illegible]tive statutory areas of supply. The words were clear: he could [illegible]

joint station or abstain from fulfilling the obvious need of the consumer. For the transmission of energy from the joint station to such consumer's premises might place on defendants a physical or financial problem of a serious kind if they were bound to take it from the joint station. Upon a careful consideration of the two agreements, he thought that they would work more clearly and satisfactorily if the word "business" be taken in the limited meaning he had adopted. He agreed that clause 3 of the agreement of 1900 was intended to strengthen caluse 10 of the 1899 agreement. But adequate reason for such accentuation of the duties of each company was to be found even if the word "business" was to be taken as meaning the supply of electricity within the statutory area. Even if the word "business" were to be taken as including a supply by defendants to external consumers under the sanction of a fringe order, he should still feel disabled from awarding damages to plaintiffs against defendants for not taking the energy from the joint station. For they were not, in his view, entitled to take it, and he could not give damages for the non-performance of an act which was beyond the powers they possessed. It followed that the award was erroneous in respect to the item of £1,661. As to head (B)—*i.e.*, the supply by defendants to external consumers in Kensal Town in 1899—it resulted, in his opinion, that that part of the award (*i.e.*, for £189 damages) was also erroneous, subject to the subordinate point hereafter mentioned. The reasons already given with respect to head (A) applied. Such supply was not, he thought, a part of the business of defendants within the meaning of clause 3. It would have been *ultra vires* the powers given by the Joint Act of 1899 for defendants to supply such consumers from the joint station. Such supply, moreover, was without any authority whatever. No permission had been obtained from the Board of Trade. No fringe order had been granted. Not only would a supply from the joint station for such consumers have been beyond the powers and rights given by the Joint Act of 1899, but the supply was in fact in direct contravention of clause 6 of defendants' provisional order of 1889. Two other points arise on the award. One of the consumers in Kensal Town was a Catholic school, which was outside defendants' statutory area; but the school was adjacent to a church and connected therewith. The church was within defendants' area. Defendants conducted their supply to the school. They did not directly carry it themselves to the church; but the school had connected their fittings to the church, and thereby gave it a supply of electricity. The energy supplied to the school was not obtained by defendants from the joint station, but from third persons. It was not generated at their own sources. No fringe order was obtained for the supply to the school. Did defendants commit a breach of contract in not taking the energy used at the school from the joint station? The arbitrator had answered "Yes," for his award included damages in respect thereof under the item of £189. The amount of such damages, however, had not been separately assessed. Mr. Tomlin contends that such damages are wrongly given against defendants, for the supply was actually delivered to the consumer outside the area, and that when once the energy is placed at the disposal of the consumer the responsibility of defendants ceased. The limit of defendants' function was reached, it was said, when their service line met the lines of the school at the outside of such premises. Defendants submitted that the decision of Mr. Justice Neville in Attorney-General *v.* Leicester Corporation saved them from liability. That decision was followed by Mr. Justice Eve in Attorney-General *v.* Sheffield; but in his opinion those cases merely decided that an ordinary municipal authority possessed of powers under a provisional order granted pursuant to the Electric Lighting Acts was not entitled to carry on trade in electric fittings or to provide any electric lines, apparatus or fittings for the premises of the consumer. He was unable to see that the above cases affected the point before him. Defendants supplied the school outside their area with electricity in breach of their statutory duty and without any colour of legal justification. A portion of such electricity was then used by the said consumer for lighting a building within the statutory area. Such electricity could and ought to have been taken from the joint station, and he saw no reason for holding the defendants free from liability in respect of the electricity [illegible] Catholic church. [illegible] question of damages in respect of the church, the case must, unless the [illegible] either from their own sources or from the joint station. It was obtained [illegible]

the agreements of 1899 and 1900. It was further argued that such a modification of the *prima facie* meaning of the word "require" should be introduced into the contract as an implied term thereof and in order to make it a satisfactory working arrangement between the parties. He saw no ground for introducing such an implication into the contract. He thought the implication suggested by Mr. Tomlin would not only negative the *prima facie* meaning of the word "require," but would clearly oppose the general intent and scheme of the parties as expressed in the agreements of 1899 and 1900. Hence, it could not be allowed. The award before him, which was stated in the form of a special case, did not contain any finding of fact save in one or two circumstances mentioned in paragraph 4 thereof. Mr. Swinburne was a most distinguished expert and not a lawyer, but he felt that it was most desirable, and indeed essential, that every special case, whether stated by a lawyer or a layman, should contain a statement of every relevant fact as found by the arbitrator. With regard to the costs of the special case, defendants had succeeded to a large extent, but they had failed on some heads of the award, and several of their unsuccessful contentions occupied a substantial measure of time. Hence, he thought that their costs should be taxed, and that they should receive two-thirds only of the total costs allowed. With regard to the costs before the arbitrator, it sufficed to say that he had dealt with them in the award with the exception of the small point as to the supply to the church.

Patent Record.

SPECIFICATIONS PUBLISHED.

The [illegible] have been specially [illegible] Marks & Clerk, Chartered Patent Agents, 70 and 72 [illegible]

Where [illegible] was lodged at the Patent Office the former is given in brackets after the title.

[illegible]

[illegible] currents. (9.12.16.) 111,885.

[illegible] transmitters. (9.12.16.) 111,887.

[illegible]

17,930 BRITISH ELECTRIC TRANSFORMER CO. & GOODMAN, J. Protective means for [illegible]

[illegible] 102,738.

[illegible]

1917 SPECIFICATIONS.

[illegible]

313 AKT[illegible]

468 SP[illegible]

[illegible] (13.1.16.) 103,487.

[illegible] J. & D[illegible]

[illegible] (13.4.17.) 111,968.

[illegible]

APPLICATIONS FOR PATENTS.

[illegible]

December 18, 1917.

18,7[illegible] [illegible]

18,7[illegible] [illegible]

18,789 B.T.-H. CO. (G.E. Co.) Electric cut-outs.

18,796 AUTOMATIC TELEPHONE MFG. CO.

December 19, 1917.

18,[illegible] [illegible]

18,8[illegible] & 18,8[illegible] [illegible]

18,876 WAT[illegible] ELECTRIC & MFG. C[illegible] [illegible]

December 20, 1917.

18,000 CUNNINGHAM. Electrolytic processes.

18,900 CHANCE & HUNT & MOTT & SMITH. Electrolytic processes.

18,920 LATOUR. Audion or lamp relay or amplifier. 20.12.16. France.

December 21, 1917.

18,93[illegible] [illegible]

18,953 LANGDON DAVIES & SOAMES. Electromagnetic clutches.

18,954 CALLENDER'S CABLE & CONSTRUCTION CO., WATSON & BENNETT. Insulated cables, &c.

18,963 POYNTER. Dynamo-electric machines, &c.

18,970 [illegible] energy.

December 22, 1917.

18,993 A.B.C. Motors (LTD.) Spring drive for magnetos, &c.

19,004 BARRATT. Trolley guide for electric frame.

19,011 BALCOMBE & DAWSON. Electrical steering of vessels.

December 24, 1917.

19,046 CAIRNS. Electric lamps.

19,050 REES & TAYLOR. Overhead trolleys or collectors for electric tramways, &c.

19,063 FULLER ACCUMULATOR CO. & WELCH. Spring terminals for accumulators.

19,064 FULLER ACCUMULATOR CO. Electric safety lamp cases.

19,065 THOMPSON. Manufacture of carbon electrodes.

19,082 CHEMISCHE FABRIK WEISSENSTEIN & WALTER. Diaphragms for electrolytic cell

December 27, 1917.

19,090 MILLER. Rectifier for wireless telegraphy.

19,096 THOMPSON. Controllers of d.c. motors for hoisting apparatus, &c.

19,099 MARR. Telephone transmitters.

19,108 BEATTIE. Electromagnetic methods of detecting submarines.

19,110 LOVETT, PYNE & MANIFOLD. Electric cable junction fittings.

[illegible]

[illegible]

19,135 DARDELET. Pocket electric lamp. 2.11.17. France.

December 28, 1917.

19,150 TEASDALE-BUCKELL. Telephone and microphone receivers.

19,159 LANE. Self-engaging cog for electric machines.

19,170 LEECH & SLATER. Electrolytic preparation of metals or alloys in the form of paste, sludge or sponge.

19,191 DAVIS & TWIGG. Electric switches.

December 29, 1917

19,239 ALLEN & NORTH. Interrupters or contact breakers for magneto-electric machines.

December 31, 1917.

[illegible] machines.

19,280 WESTERN ELECTRIC CO. Party line ringing systems.

19,290 BIJUR MOTOR LIGHTING CO. Electric systems for motor vehicles, &c. (30.4.17, U.S.)

19,322 MELLERSH-JACKSON. (Leonard & Allen.) Electric heating apparatus.

19,351 LARSON. Alternating-current electromagnet.

January 2, 1918.

31 CAUNTER. Electric heating elements.

[illegible]

57 ARN[illegible]

32 R[illegible]SS. [illegible]

71 BELL. [illegible]

79 FRANKL[illegible]

112 WHITLEY [illegible] systems.

[illegible]

Volunteer Notices.

COUNTY OF LONDON VOLUNTEER [illegible]

[illegible]

Commercial Topics.

Trade Commissioners Service.

The following arrangements and appointments in connection with H.M. Trade Commissioners Service within the Empire are announced :—

Mr. C. Hamilton Wickes, who has been Trade Commissioner in Canada, will for the present remain attached to headquarters at the Department of Overseas Trade (Development and Intelligence).

Mr. G. T. Milne, now Trade Commissioner in Australia, will shortly proceed to Montreal to act as senior Trade Commissioner in Canada.

Mr. S. W. B. McGregor will shortly proceed to Melbourne to succeed Mr. Milne as senior Trade Commissioner in Australia.

Mr. W. G. Wickham will continue to serve as the senior Trade Commissioner in South Africa.

Mr. R. W. Dalton will continue to serve as Trade Commissioner in New Zealand.

Mr. T. M. Ainscough, O.B.E., has been appointed as senior Trade Commissioner in India, and will shortly proceed to Calcutta.

Mr. J. L. Wilson Goode will serve as Acting Trade Commissioner in South Africa during Mr. Wickham's absence.

Mr. F. W. Field will shortly be appointed to the Trade Commissioner Service, and will be stationed at Toronto, where he is now Imperial Trade Correspondent.

* * * *

Government and Contract Prices.

The Treasury has appointed a Committee consisting of Lord Inchcape (chairman), Lord Colwyn and Sir Peter H. McLelland, to inquire into the steps which have been taken by the Admiralty, the War Office and the Minister of Munitions to control contract prices and to limit profits; and to consider in what respects the practice of these departments can be co-ordinated and improved.

* * * *

Hardware Imports.

The Department of Import Restrictions notifies that the general licences at present in operation in respect of certain articles of hardware will be revoked as from Feb. 1. After this date special licences will be available under certain conditions for regular importers and [illegible] and this licence will be issued on a ration [illegible].

Applications for licences should be made to the Department of Import Restrictions, 22, Carlisle-place, London, S.W. 1.

* * * *

Control of Spelter.

In a new Order by the Minister of Munitions, extending the Order of March 23, 1917, as to the control of spelter, it is laid down that :

[illegible] spelter shall mean spelter of all qualities, and shall include sheet and rolled zinc, scrap zinc, hard spelter, dross, zinc ashes, flux skimmings, zinc dust, zinc ore, zinc oxide, zinc sulphide (or lithopone) whether dry, in oil or prepared for use, and zinc compounds of [illegible].

* * * *

British Trade Corporation.

The first report of the Corporation from April 21 to Dec. 31 [illegible] capital of £2,000,000 has been paid up by [illegible] on Dec. 31, 1917.

[illegible] the management has been principally engaged in making the necessary arrangements for representation in foreign countries and other business details. It has, however, [illegible] in connection with overseas [illegible] Committees pointed to the desirability of making arrangements for the insurance of [illegible] been set up. The [illegible] income tax, the [illegible] £9,671 to be applied [illegible].

* * * *

Siemens Brothers & Co.

In the House of Commons on Tuesday Sir Albert Stanley stated [illegible] Siemens Bros. & Co., Ltd., [illegible] vested in the Public Trustee [illegible] No company had [illegible] purchasing the shares. One of the [illegible] should be [illegible] that the control of the company [illegible] the Public Trustee [illegible].

* * * *

A Tax upon Invention.

[illegible] Committee, [illegible] patent [illegible].

[illegible]

burdened in this way. It was necessary to stimulate research work, and he considered that the abolition of the patent tax was a suitable subject to take up, especially at the present time, when the revision of the patent laws were under the consideration of the Government.

* * * *

Electric Furnace Progress.

Although the Greaves-Etchells electric furnace was not introduced until 1916, the number of orders secured for it in Great Britain stands second only in the list of makers. The numerous plants installed in Sheffield and various parts of the country are employed on alloy steels, high-speed steels, carbon steels and steel castings.

During the past year the furnace was introduced into the United States. The U.S.A. Government have ordered five furnaces of large capacity for their arsenals and dockyards, whilst orders have been received from the Halcomb Steel Co., Ford Motor Co., National Radiator Co., Singer Mfg. Co., Stoddart Union Steel Co., Primos Chemical Co., and others. Dr. Matthews, the head of the Halcomb Steel Co., installed the first electric furnace in the United States in 1906, and after 11 years' experience of electric melting he has now adopted the Greaves-Etchells. The Ford Motor Co. is using the Greaves-Etchells furnace to make castings for the "Liberty" aircraft motor.

Three of the Greaves-Etchells furnaces are also on order for armanent works in Spain, and one is being supplied to New Zealand to be employed on producing steel castings from scrap. The furnaces in use in Sheffield have, it is reported, turned out a considerable tonnage of high-speed steel of satisfactory quality.

Electricity Supply.

Extensions.

Bermondsey (London).—The London County Council have sanctioned a loan of £3,000 for the provision of a rotary converter.

Under the terms of an agreement between the Council and the London Electric Supply Corpn. for the supply of electricity in bulk, the Council is required within 18 months of the date of the agreement to install a suitable converter with the necessary switchgear. As it is doubtful whether beneficial use can be made of the converter on the termination of the period of the agreement, which is for three years, the London County Council have fixed the period of repayment at three years, to be extended to the usual 15 years from the date of borrowing if the converter continues to be of beneficial use to the Council.

Cardiff.—The Corporation has secured sanction to a loan of £400 for cables and switchgear.

Greenock.—The Corporation have applied to the Secretary of Scotland for sanction to borrow £51,500 for immediate extensions of the electricity undertaking.

Islington (London).—The London County Council has sanctioned the borrowing of £53,000 for the purposes of the electricity undertaking.

£28,000 is for a 5,000 kw. alternator, condenser, &c., £14,000 for two water tube boilers, steam pipes and valves, and £11,000 for coal bunkers and conveying plant. The sanction is given on condition that the Council repays the outstanding loans upon displaced plant, boilers and works. Eight boilers have recently been disposed of, and two generating sets will be displaced by the new set. The total amount involved is £7,407, and instead of repaying this sum only, £45,593 will be raised by loan. The London County Council raise no objection to this, provided the unexpired terms of the outstanding 42 year loans are reduced to 15 years from the present time.

Manchester.—The City Treasurer has been authorised to borrow £20,000 for the electric supply department.

Mansfield.—The Council have decided to apply for sanction for extensions of the electricity generating plant and mains at an estimated cost of £20,500.

Plymouth.—The Electricity Committee recommend that application be made to the L. G. Board for sanction to borrow £24,170 for for turbo generator, £3,500 for a converter and £6,400 for new cables and switchgear.

St. Pancras (London).—The chief electrical engineer (Mr. S. Baynes) has reported to the Electricity Committee that having regard to the shortage of plant, and the ever increasing power load, also the poor running efficiency obtained by operating with small units of plant, it is desirable to obtain two Ljungstrom turbines at a cost of £35,000.

It would also be necessary to spend £6,900 on foundations, switchgear and connections, pump house and circulating pipes, &c. The two Browett Lindley engines could then be done away with, and with a [illegible] certificate, the makers of the turbines anticipate that they could deliver and erect the proposed new sets in seven or eight months. The present load is over 6,000 kw., but owing to shortage they were unable to keep up the full pressure on the mains at maximum load times, otherwise the figure would reach some 6,500 kw., and Mr. Baynes anticipated a considerable further increase on this figure. During the twelve months to date they had generated over $17\frac{1}{2}$ million units, and consumed [illegible] 000 tons of coal. By running the two 3,000 kw. turbines

and the new boilers they could handle the present load with modern plant, and effect an economy in coal of about 14,000 tons per annum, which would effect a saving of nearly £22,000. He found that the Ljungstrom turbine was more economical for their purpose; and any attempts to put in a 5,000 kw. set would involve considerable expenditure in alterations to buildings and the provision of a travelling crane.

The Committee, after considering the matter, adopted the engineer's recommendation.

The Ministry of Munitions has intimated that it is not desirable to connect new customers who already have alternative methods of obtaining light, heat or power, or business premises not used directly or indirectly for war work.

General.

Callan (Ireland).—A fire, which occurred at the local electricity works on the 18th inst., caused damage estimated at £3,000.

Dublin.—The Engineer to the Port and Docks Board has reported on the question of electricity supply.

The generation of a supply by the Board would entail capital expenditure of not less than £6,000 within three years: the replacing of existing plant would amount to from £14,000 to £16,000, of which sum almost one-half would be for reserve plant. If current in bulk were taken from the Corporation, the capital for converting plant would be £5,000, and for a combined day and night load the Corporation should supply at 1d. per unit, to which would be added cost of superintendence, &c., estimated at (say) 1d. per unit. It might be possible to effect an annual saving of £2,000 in running costs and of £10,000 in capital expenditure by purchase in bulk.

Officials of the Corporation electrical department have suggested the following methods of rendering Corporation supply available: (*a*) By crossing the Liffey near Ringsend and bringing a h.t. supply into the port's generating station; (*b*) by erecting a sub-station at Rogerson's Quay, transforming and converting the h.t. current to pass into the Port Board's main on the south side, and thence across the river by the existing submarine cables; (*c*) by taking a branch off the Clontarf supply, carrying same along the East Wallsroad and thence to the port power station.

The report is to be printed and considered at an early meeting of Board.

Electricity Supply in Greater London.—On the 16th inst. a private conference of representatives of municipal electricity undertakings in Greater London was called in order to consider the question of the bulk supply of electricity within the area of the L.C.C. and in Greater London. Owing to the engagement clashing with another conference there was a poor attendance, and it was decided to postpone the matter and to call another meeting.

Increased Charges for Electrical Energy.—The charges for current at the following places are being increased.

At [illegible] the charges are being increased by 20 per cent.

At Halifax the charges are being increased by 12½ per cent.

[illegible] Council has increased the charges to private consumers by 10 per cent., making a total increase of 20 per cent.

The [illegible] of London Electric Supply Co. is increasing its charges by 10 per cent., making a total increase of [illegible] per cent. for power and 5 per cent. (total 30 per cent.) for lighting.

[illegible] The charges at [illegible] have been increased by ¼d. per unit for lighting and ¼d. for power and heating (not ½d. as stated in our last issue).

Monasterevan (Ireland).—A supply of electricity is now available in the district. The engineer responsible for the scheme is Mr. P. [illegible], and the contractors are Messrs. [illegible] H. [illegible] & Co.

Mytholmroyd.—The Urban Council has consented to the application of Halifax Corporation for a provisional electric lighting order.

Private Bill Legislation in 1918.—The Examiners of both Houses of Parliament have decided to report the following Bills as having complied with the Standing Orders: [illegible]

[illegible]

[illegible]

£300,000, but the Bill provides that the interest paid out of capital is not to operate as a reduction of the amount paid up on the shares or debenture stock, but is to be "charged by the Company to capital as part of the costs of construction of its undertaking."

Rotherham.—At a recent meeting of ratepayers, under the Borough Funds Acts, a resolution was passed approving the Bill which the Corporation are promoting, in order to acquire the electricity undertaking of the Mexborough & Swinton Tramways Co. in Rawmarsh and Swinton, to extend area of supply of their electricity, &c.

The estimates of the expense involved include £50,000 for the purchase of the electricity undertakings of the Mexborough & Swinton Tramways Co., £515,000 for the extension of the Corporation's generating station, &c., £165,000 for sub-stations, transformers, cables and mains.

Walsall.—The salary of the accountant of the electric supply department, Mr. C. W. Cookson, has been increased by £26 per annum, and that of the tramways chief engineer, Mr. J. R. Taylor, by £25 per annum.

Willesden.—Negotiations are proceeding between the Urban Council and the North Metropolitan Electric Power Supply Co. for the continuation of bulk supply after March 31, 1918.

Application is to be renewed to the L.G. Board for permission to install two new 500 kw. rotary converters at a cost of £5,400.

Telegraphy and Telephony.

Chinese Telegraphs.—At the end of 1917 there were 40,016 miles of aerial land lines in the country, with 56,412 miles of conductors, against 25,308 and 41,805 miles, respectively, in the previous year. There were also three submarine cables with an aggregate length of 2,002 nautical miles.

Wireless Operators' Wages.—The Association of Wireless Telegraphists, which is stated to have a membership of over 2,000, has demanded an immediate increase of 100 per cent. on pre-war rates of wages.

The demand has been submitted to the Deck Officers' Panel of the Conciliation Board, but the association's executive complain that, although their organisation is representative of all the highly skilled wireless operators in the service, no representative of the association had been invited to take part in the proceedings. Marconi's Wireless Telegraph Co. has intimated that if a majority of the members expressed a desire "recognition" would be extended to the association.

Electric Traction.

Blackburn.—The tramway workers have tendered notices to cease work on Feb. 1 unless their claims are settled.

The men ask for the payment of a war bonus granted from the first full pay day in September last; they decline to work with non-unionists; and they object to any persons being given employment except discharged sailors and soldiers.

Glasgow Tramways.—Last week's heavy fall of snow, followed by the thaw on Saturday, had a serious effect on the tramway service in the city and 377 tramcars had to be withdrawn on Saturday.

There was a great accumulation of melting snow after the thaw set in, and the slush in the streets was so deep that it reached the motors of the [illegible]

[illegible]

The traffic on the Paisley and District Tramway Co. was also seriously [illegible]

[illegible]

Leeds.—The Tramways Committee [illegible]

[illegible]

badly in need of repair. The sections upon which it is proposed to suspend the service for the time being are Street-lane, Lawnswood and West-street. It is intended to take up a single line of rails in each section in the first place, and utilise it for repairs elsewhere. Should it be necessary, the other set of rails will be removed later. The question of purchasing rails from other towns was considered, but in view of the expense of taking up the rails, the allowance for loss of revenue and the eventual replacing of the rails, it was felt that the cost would be excessive.

The scheme for carrying parcels on the tramcars, and thus relieving the transport difficulty to some extent, has been advanced a stage further, and it is hoped to bring it into operation in about a month's time.

L.C.C. Tramways.—On Tuesday the Highways Committee reported on the congestion of tramway traffic at Victoria.

Six tramway services from various parts of South London converge at the Victoria terminus, and during the busiest hours of the day about 80 tramcars depart per hour. The number of passengers boarding and leaving the cars is greater than at any other dead-end terminus in London, and the traffic during the evening has the peculiarity that, while its outgoing is at its heaviest, the number of incoming passengers is very considerable. The Committee proposed, as the best solution of the difficulties, the construction of a loop line via Gillingham-street and Wilton-road, but neither the Commissioner of Police nor the Westminster City Council would consent. It is expected that the difficulties will be partly met by a construction, which has been put in hand, of a cross-over, providing for the increase of the number of cars loading simultaneously [illegible] six.

[illegible] Electrical Bonus.—The Committee reported having had under consideration the decision of Sir Geo. Askwith, providing that men working on time rates in generating stations and sub-stations and on mains directly concerned in the generation and distribution of electrical energy (including the technical staff) were to receive a bonus of 12½ per cent. as from the beginning of the first full pay after Oct. 13, 1917. The decision had been adopted by employers generally, and should, the Committee thought, be accepted by the Council, and applied to the grades concerned in the electrical branch of the tramways department.

A recommendation to this effect was agreed to.

Miscellaneous.

British Industries Fair.—Owing to the severe weather, the opening date of the Fair has been postponed until May 6.

Electricity in Lead Mining.—The Rheidoc (Cardigan) Lead Mining Co. proposes to put down electric generating plant for power and lighting.

Electrolytic Refining of Zinc.—It is announced that the Electrolytic Zinc Co., of Australia Proprietary, has begun operations at its plant in Tasmania.

The company was formed on May 16 last with a capital of £1,000,000 by a number of Australian producers of zinc concentrates, to erect works for the electrolytic treatment of zinc concentrates and the production [illegible]. The plant has a capacity of 100 tons per day.

Import Prohibition.—The importation into the United Kingdom [illegible] and antimony sulphate has been prohibited.

U.S.A. Truck Owners' Conference.—The third Truck Owners' Conference will be held in New York City on March 8 and 9 next.

[illegible] and a cordial invitation has [illegible] who are not manufacturers [illegible] attend all meetings. Committees [illegible] the proposed national standard cost [illegible] truck associations and [illegible]

Educational.

University of London.—[illegible]

University of Liverpool.—[illegible]

Tenders Invited and Accepted.

Telephone Material.

[illegible]

The Deputy Postmaster-General, Sydney (N.S.W.) requires tenders by 2.30 p.m. Jan. 28 for the supply of telephone and switchboard parts (Schedule 643 N.S.W.) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specification rom the Deputy Postmaster-General.

Electric Crane.

MANCHESTER Waterworks Committee require tenders by Feb. 2 for the supply of an electrically-driven Radial Arm Crane. Specification, &c., from the Secretary of the Waterworks Dept., Town Hall, Manchester.

Electrical and General Stores.

TOXTETH PARK Guardians require tenders by noon Jan. 27 for three months' Electrical and Engineers' Supplies, Ironmongery, Oils, &c. Forms of tender from the Clerk, 15, High Park-street, Liverpool.

GLASGOW.—The Tramways Committee has accepted the tender of Messrs. Dyer & Young for commutators, and that of the Micanite & Insulators Co. for leatheroid.

LEEDS.—The Council has recently placed an order with Messrs. Richardsons, Westgarth & Co. for a 6,000-kw. turbo-generator.

BRADFORD.—The Electricity Committee has accepted the tender of Hick, Hargreaves & Co. for the supply of surface condensing plant, and that of the Stanton Iron Co. for c.-i. circulating pipes.

POPLAR (LONDON).—The Borough Council has accepted the tender of Ferguson's Superheater, Ltd. (at £250) for a superheater, to cost an additional £50.

Government Contracts.—The following tenders were accepted by the British Government Departments during December 1917 :—

War Office.—Coventry Simplex Engines (Ltd.), W. H. Dorman & Co. and R. A. Lister & Co., generating sets.

H.M. Office of Works.—R. Hornsby & Sons and British Thomson-Houston Co., engine, generators and switchboard, extension at Bromley O.W. Stores; Waygood, Otis (Ltd.), lift at New Science Museum; Duncan Watson & Co., electric wiring at Ministry of Shipping St. James's Park; Colston, Electrical Co. engineering abour in Bristol district.

Post Office.—Siemens Bros. & Co., protective apparatus; British L. M. Ericsson Mfg. Co., Walters Electrical Mfg. Co. and Western Electric Co., telephone apparatus; Creed & Co., buzzer indicators; Telegraph Construction & Maintenance Co., submarine cable; W. T. Henley's Telegraph Works Co., Johnson & Phillips, Siemens Bros. & Co. and Telegraph Construction & Maintenance Co., telegraph cable; London Electric Wire Co. & Smiths and Peel-Conner Telephone Works, telephone cards; Beardsmore & West and W. Makinson & Sons, wood drums; Doulton & Co., stoneware ducts; J. Macintyre & Co., insulators; Crystalate Mfg. Co., telephone Mouthpieces; British Insulated & Helsby Cables, cable distribution plugs; T. Bolton & Sons, bronze wire; C. Macintosh & Co. flameproof wire.

Appointments Vacant and Filled.

A constructional engineer is wanted to take charge of the erection of large power station. Applications to Director of Electric Power Supply, Ministry of Munitions, 8, Northumberland-avenue, London, W.C. 2. *See advertisement.*

A senior lecturer in electrical engineering is required for the Portsmouth Municipal College. Salary £200, rising to £250 by £10 annual increments. A workshop instructor in electrical engineering is also required at the College. Forms of application from the Secretary, Mr. H. E. Curtis. *See advertisement.*

A woman lecturer in electricity is required at the Merchant Venturers' Technical College, Bristol. Salary £250 per annum. Particulars and forms of application from the Registrar. *See advertisement.*

A teacher is required to organise and conduct classes for training disabled soldiers in electrical subjects; part-time engagement; salary about £4 per week. Particulars from the Clerk, Education Offices, Catharine-street, Cardiff. *See advertisement.*

A switchboard attendant is required by the Derby Corporation electricity department. Applications to Borough Electrical Engineer, Full-street, Derby. *See advertisement.*

[illegible] Electric Supply Co. (Ltd.) requires an engineer and [illegible]. Application to the Chairman. *See advertisement.*

A shift engineer is wanted for South Shields Electricity Department. Commencing salary £3 per week. Application to the Borough electrical engineer, Mr. H. S. Ellis. *See advertisement.*

A theatrical electrician is wanted for a provincial theatre. *See advertisement.*

A foreman is required for electrical instrument works. *See advertisement.*

An electrical engineer is wanted for the maintenance of electrical plant at Edmonton, London, N. *See advertisement.*

[illegible] Tramways Committee require a workshop superintendent. Commencing salary £400, rising to £500 per annum. Applications to General Manager by Feb. [illegible].

Applications are invited for the post of Head of the Department of electrical engineering and physics of the Victoria Jubilee Technical Institute, Bombay. Salary Rs. 700. Applications by March 31, 1918, to Mr. D. E. Wacha, Honorary Secretary of Board of Trustees, Byculla, Bombay, India.

Mr. J. R. Walker has been appointed an assistant engineer at the Greenwich power station of the L.C.C. Tramways Department.

Business Items.

The address of the Sheffield branch of the India Rubber, Gutta Percha & Telegraph Works Co., Ltd., is now at 88-90, Queen-street, Sheffield.

Jas. Stevens and Robt. F. Brown, electrical engineers, 19A, Mains-street, Glasgow, have dissolved partnership. Debts by Mr. Brown, who will trade in his own name at the same address.

The business of Messrs. E. G. Appleby & Co., Ltd., 12, The Broadway, Westminster, S.W.1, has been converted into a private limited company, for family reasons, and with a view to taking into partnership Mr. G. H. Bentley and Mr. W. E. Lee, who have for many years helped in the successful development of the business. The company will trade as E. G. Appleby & Co., Ltd., and the business will be continued under the same management.

Automatic Circuit Breakers.—The British Thomson-Houston Co. have recently issued list No. 4,221, which gives illustrated particualrs and prices of their automatic circuit breakers for alternating and continuous current circuits.

Foreign Propaganda.—Messrs. Vickers (Ltd.), Broadway, Westminster, S.W.1, has recently issued a neat pamphlet (P.V. 101) in English, French, Spanish and Italian, containing some typical examples of the electrical plant manufactured by the company.

The pamphlet is well printed and the illustrations and views of the generating sets, motors and electrically driven machinery are so clear and beautifully printed that those who receive the pamphlet will be fully impressed by the capacity of the company to supply all requirements for industrial power and lighting purposes.

The company has also issued neat blotters bearing illustrations of some of its manufactures, with descriptions in English and other languages.

Wotan Traction Type Lamps.—Messrs. Siemens Bros. Dynamo Works (Ltd.) advise us that Wotan traction type lamps have been adopted for use on the L.C.C. tramways and a contract has been placed with them to cover the total requiremenrs for the ensuing 12 months. The number of lamps required will be approximately 150,000.

Lamp Fittings.—Engineering & Arc Lamps (Ltd.), Sphere Works, St. Albans, have issued their list of specially designed fittings, suitable for use with half-watt and metal filament lamps. A considerable number of alternative designs are shown, particularly suitable for works and industrial [illegible]

[illegible]

Flash Lamps and Electrical Accessories.—[illegible]

[illegible]

Plant Wanted.—[illegible]

Liquidations.

[illegible] Mr. Reynolds.

[illegible]

[illegible]

Companies' Meetings and Reports.

ADELAIDE ELECTRIC SUPPLY CO. (LTD.)—The report for the year ended Aug. 31, 1917, states that £6,727. 6s. has been applied in writing off sundry items of plant and capital expenditure, and the total capital expenditure (including £40,628 spent during the year), less amounts written off (£18,801), is £923,635. The gross revenue for the past year was £154,451, compared with £136,541. 1s. 11d. for 1915-16, an increase of 13 per cent. After payment of management and general expenses in London and Adelaide, and after providing for debenture stock service fund and allocating £5,000 to reserve for income tax and excess profits duty, the balance was £58,211. Deducting the preference dividend for the half-year ended Feb. 28, 1917, and the interim ordinary dividend of 5 per cent., there remained £33,612. The directors recommend payment of the dividend on the 6 per cent. preference shares for the half-year ended Aug. 31, 1917 (£7,500), and a final dividend of 7 per cent., tax free, on the ordinary shares, making 12 per cent. for the year (£24,472. 11s. 4d.), leaving £1,639. 15s. 2d. With £9,160. 12s. 5d. brought forward, the total credit balance to be carried forward is £10,800. 7s. 7d. Notwithstanding the adverse influence of the war, the steady development of the company's business continues. There are 19,500 consumers (against 17,732), and the total connections (including 10,221 H.P. in motors) are equal to 24,641 kw. (against 22,6147 kw.). The units sold were 9,330,495 (against 8,388,345). The area of the districts covered by the company's statutory powers is approximately 155 sq. miles, with a population of 224,000; and a supply is now available in 400 miles of streets, an increase of 20 miles during the year. During the year the power supply increased by 10 per cent., and the total connections (including lamps, motors, heating, cooking and other apparatus) increased by 9 per cent.

BRITISH ALUMINIUM CO. (LTD.)—At an extraordinary meeting last week a resolution was passed empowering the Company to proceed with their Bill for powers to construct works for developing their undertaking and generating electric power, &c. The chairman (Mr. A. W. Tait) said that they had been fortunate in finding what he believed to be the largest available water power in Great Britain, and all the more so as it was capable of development adjacent to their Kinlochleven factory, at present the largest hydro-electric station in the country. The economy resulting from concentration of production was obvious. The scheme involved the erection of a dam at the outflow of the River Spean from Loch Laggan, a tunnel or aqueduct therefrom diverting into Loch Treig the waters draining into Loch Laggan, the collection of a number of streams flowing down the Ben Nevis range, [illegible] and finally a tunnel, approximately nine miles in length, to convey the water from Loch Treig to a point above Kinlochmore. The power available at [illegible] was estimated to be of approximately 60,000 H.P., and the cost of the water-power development was estimated by their engineers [illegible] at £1,591,876 [illegible] and incidental expenditure.

MELBOURNE ELECTRIC SUPPLY CO. (LTD.)—[illegible] directors for the year ended Aug. 31, 1917, states that the total [illegible] capital expenditure [illegible] £1,188,574 [illegible] a total of £1,372,101 [illegible] £21,940 [illegible]

[illegible]

exclusive of the bulk supply which [illegible]

[illegible]

New Companies, Mortgages and Charges, &c.

New Companies.

BASEBE, SADLER & CO. (LTD.) (149,362.)—Private company. Reg. Jan. 11, capital £7,000 in £1 shares, to enter into an agreement with Z. C. Basebe and J. Sadler (trading as "Basebe, Sadler & Co.") and to carry on the business of electrical and mechanical engineers and contractors, smiths, machinists, tool makers, &c. First directors are A. C. Basebe and J. Sadler. Reg. office: 49, Goschen-buildings, Henrietta-street, W.C. 2.

BIRMINGHAM ELECTRIC SUPPLY CO. (LTD.) (149,377.)—Reg. Jan. 15, capital £2,000 in £1 shares, to carry on at Birmingham and elsewhere in Derby the business of an electric lighting and supply company, &c. First directors are H. Phipps, H. H. Beresford, C. E. Tissington and R. W[illegible]n, all of Chesterfield.

MULTIPLE FUSES (LTD.) (149,397.)—Private company. Reg. Jan. 17, capital £1,100 in £1 shares, electrical engineers and contractors, suppliers of electricity, manufacturers of and dealers in electric and galvanic apparatus, rubber, asbestos, insulating and other materials, &c. First directors are E. S. Conradi and J. F. Conradi. Reg. office: 6–8, Rosebery-avenue, E.C. 1.

Mortgages and Charges.

LAING-WHARTON (LTD.)—Mortgage debentures dated Jan. 4, 1918, to secure £700, charged on Company's undertaking and property, present and future. Holder: Minister of Munitions.

City Notes.

ANGLO-AMERICAN TELEGRAPH CO. (LTD.)—The directors have declared the following dividends to close of year 1917: Balance dividends of £[illegible] 10s. per cent. upon the ordinary consolidated stock and of £1. 10s. per cent. upon the preferred stock (both less tax) and a first and final dividend of £1. 10s. per cent. upon the deferred stock (less tax). Dividends are payable Feb. 1, and with those already paid will amount to £3. 15s. per cent. upon the ordinary 6 per cent. on the preferred, and £1. 10s. per cent. on the deferred stock for the year.

COMPANIES STRUCK OFF THE REGISTER.—The following companies were struck off the Register of Joint Stock Companies on Jan. 18: Acton Battery Co., Electrical Sales Promotion, London Battery & Mfg. Co., Mies' Electrical & Chemical Culture, Pho-Telegraph & Cable, Scandinavian Waterpower & Paper Mills, United Cablegram Co. of France.

The following will be struck off the Register unless cause to the contrary is shown before April 18: [illegible] Electric Sign Co., Electrical [illegible] Magneto & [illegible] Co.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.)—The [illegible] on the Company's 4 per cent. mortgage debenture stock for the half-year ending 31st inst. (due on the 1st prox.) will be paid by [illegible] will be closed from the 28th to the [illegible].

ELECTRIC SUPPLY CO. OF VICTORIA (LTD.)—The tramway and lighting [illegible] for the three months ended Sept. 30 last [illegible].

ISLE OF THANET ELECTRIC TRAMWAYS & LIGHTING CO.—The [illegible] Sept. 30 last [illegible] of £1,731, which [illegible].

MARCONI'S WIRELESS TELEGRAPH CO. (LTD.)—[illegible]

[illegible]

[illegible]

[illegible] TRAMWAY, LIGHT & POWER CO. (LTD.)—[illegible]

The Round Table.

By "kVA."

The Germans are using iron for the manufacture of commutators. Surely this must mean that the iron has entered into their souls as well as their poles!

* * * *

Congratulations and hearty good wishes to Mr. H. Faraday Proctor upon his completion of a quarter of a century at Bristol. We shall have big things in power supply in the West if he continues to carry on as he has done. He enjoys a reputation for an undecipherable signature, but in this he is consistently electrical, for his writing of his name is truly non-inductive; it appears to be, even if it is not, wound back on itself!

* * * *

"The Skyscraper," to which I referred in a recent issue, is a publication intended to cheer up the lads of the London air defence, searchlight section. I should say that it succeeds admirably. It is conducted by the men who "spot" the Hun during his attacks on the Metropolis. The copy sent to me is No. 3, Vol. III., and judging by the "ads." the venture should leave a margin for cigarettes *and* beer! The sketches are cleverly done and are quite apropos of the work of the corps. The editors and their assistants are to be congratulated upon an altogether happy production.

* * * *

NEW GUARD: Orl right, Father Christmas, bung it in me stockin'. I'm not looking.

OLD GUARD: !!! ??? D!

[From "The Skyscraper."]

* * * *

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, Jan. 22, 1881.]

THE SNOWSTORM.—The unprecedented snowstorms and gales raging during the early part of this week have caused extensive interruption of telegraphic communication throughout the country, and when we went to press public notice of delay to all parts was still in force.

THE RONALDS LIBRARY.—A curious instance of the difference between nominal and intrinsic worth is furnished by the probate valuation of this important gift to the Society of Telegraph Engineers. The whole of the books, &c., included in the bequest were estimated at £146. 7s. For once in a way the legatees cannot complain of exorbitant legacy duty.

LIVERPOOL DOCKS.—The system to be used for the electric lighting of the new portion of the Liverpool Docks is the Gramme. Mr. Killingworth Hedges, C.E., made a series of experiments with this and other systems for the purpose of ascertaining which was most suitable for the lighting which comprises the dock entrance, sheds and graving dock. The plan submitted having been approved of by the board, the work is to be commenced at once under Mr. Hedges's superintendence.

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

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CONTENTS.

Notes.

Experiments in Electro-Culture.

Owing to the increased importance of home-grown food at the present time, electro-culture has assumed a position of greater interest. A number of experiments are being conducted in this direction, and among those who have the matter in hand is Mr. S. E. Britton, city electrical engineer of Chester. In a report which he has made to the Electricity Committee, and which will be found on another page, Mr. Britton gives the results obtained with three varieties of potato. It is noticeable that in the case of one variety an increase of 23·5 per cent. was found over the production under natural conditions; in the second case, increases of 117 per cent. and 153 per cent. were found, and in the third case a decrease of 3·1 per cent. in one instance, and an increase of 7·5 per cent. in another were obtained. The view expressed by Mr. Britton is that electro-culture has very great possibilities, and that when it is more understood some astounding results may be expected, but that it will take years to develop. Consequently, with the present state of knowledge its general application would not be warranted. He makes the suggestion that the most useful progress would probably be made by encouraging electricity supply undertakings in co-operation with plant physiologists to experiment systematically on small plots. Judging by the results of his experiments we think that Mr. Britton is justified in the conclusion he has reached. It is undoubtedly surprising that in three varieties of the same root the increase in one case is negligible, in the second case is substantial, and in the third case is very large. One would expect all varieties of potato to behave very much alike under the stimulus of electric discharge, but apparently this is not the case. There is, of course, the difficulty that there are many varieties, and great care must be taken that the conditions are precisely the same when experiments are made, except in the stimulus applied. We think the real difficulty, however, is due to the fact that we do not know at present the mechanism of the process. We do not know what really happens, and therefore we cannot say on what conditions the growth depends. Until this knowledge has been obtained we are likely to grope in the dark, and to obtain inconsistent results.

New Principles in Street Lighting Units.

While we in this country have naturally not been able to occupy ourselves with experiments in new street lighting units during the past three years, it is interesting to note the methods coming into use in the United States, which methods are specially adaptable for use with gas-filled glow lamps. There have hitherto been two schools of thought—those who aimed chiefly at diffusion of light and elimination of glare, without being much concerned with uniformity of distribution of light; and those whose chief aim it was to produce as nearly as possible uniform illumination between two successive lamp-posts. This led to two classes of fittings, those involving opal globes, and those using "refractors"—*i.e.*, prismatic glass devices intended to bend the rays at a small angle below the horizontal, and produce an approximation to the ideal polar curve for uniform illumination. An opal globe softens the light, but cannot greatly influence the distribution, and the resultant illumination is uneven; it is also said that this form of lighting is unsuitable for revealing small irregularities on the surface of the pavement. On the other hand, the refractors, by concentrating the light at angles slightly below the horizontal, inevitably tend to produce an impression of glare. A form of unit which is a combination of diffusing globe and refractor, and is thus a compromise between the two types, was recently described by Mr. Ward Harrison before the Illuminating Engineering Society in the United States. It uses an inner refractor to redistribute the light, and a stippled outer globe to diffuse it. It is said to combine the advantages of both types of unit, and to be, in addition, weatherproof and easy to clean.

New Engineering Industries

At the present time committees seem to be the order of the day, and so we note that another one has just been appointed by Dr. Addison, the Minister of Reconstruction. There appears to be very good reason, however, for the appointment of this new Committee, which is to consider the provision and development of new industries in the engineering trades. The duties of the new Committee will be to compile a list of articles suitable for manufacture by British engineers, which were either not made in the United Kingdom before the war, or were made in insufficient quantities, and for which there is likely to be a demand after the war. The Committee will also make recommendations as to the development of these new industries by the transfer of labour or machines, or by other measures. We are particularly glad to see that a Labour Advisory Panel is also being formed, consisting of representatives of skilled, semi-skilled and unskilled workers and of women, on whom these new industries will depend. Such a panel should ensure proper consideration of the labour problems which necessarily arise.

Association of Mining Electrical Engineers.—Referring to our note last week on Mr. J. H. C. Brooking's Paper on "Cable Complaints," the author informs us that his statement in regard to the undesirability of laying bitumen cables in the ground was subject to considerable qualification. This we quite appreciate, but in the very brief reference which we gave it was impossible to go into details.

British Engineering Standards Association.—Application has been made to the Board of Trade for a licence to authorise the formation of an association under the name of "The British Engineering Standards Association," to be registered with limited liability without the addition of the word "Limited" to its name. Objections must be made to the Controller of the Companies Department of the Board of Trade, 55, Whitehall, London, S.W., before Feb. 16.

Electric Dumping Platforms.—Electrical methods of transferring trucks into ships and boats seem to be growing in favour, and a recent note in "Elektrotechnik und Maschinenbau" refers to developments in this direction in Germany. When the dumping takes place on land conditions are comparatively simple, but in such cases as those referred to above allowance has to be made for a variable height of water level changing with the tides. One of the largest of such installations is at Duisberg-Ruhrort, where a total of 1,050 railway trucks is handled by seven electrical dumpers in a period of 10 hours daily.

"Beama Journal."—The "Beama Journal" for January contains some interesting articles of a topical character. Capt. J. M. Scott Maxwell deals with "Capital, Labour, Government and the State"; whilst Major C. H. Douglas deals with the difficult subject of "Payment, Remuneration and Results." "The New Social Contract" is the subject chosen by Mr. Huntly Carter. It will be noticed that these articles deal with economic and social problems with which we are all very vitally concerned at the moment. Other articles, which are of a more technical character, include one by Mr. A. A. Campbell Swinton on "Scientific Research," and one on "The Dangers of the German Patent System," by Mr. James Keith.

Institution of Electrical Engineers.—At the last meeting the President said it would be remembered that he had announced that if sufficient support were forthcoming, arrangements would be made for members to dine together after the meeting. That announcement was made at a rather unfortunate time, as the Paper read on that occasion, like that read at the present meeting, was on a subject which did not attract many of the members who usually attended. The next meeting would be on February 7th, when the Ninth Kelvin Lecture would be delivered by Prof. Magnus Maclean, and, as there would be no discussion, the meeting would be finished early, and the Council were quite prepared to make the same arrangement for a dinner after that meeting if sufficient support were forthcoming.

Allen West Engineering Society.—The usual fortnightly meeting of the above Society was held in Brighton on Jan. 22, when a lecture was given on "Auxiliary Machinery of Rolling Mills," by Mr. [illegible] of Messrs. [illegible] Ltd.

[illegible]

Transactions of the Institution of Engineers and Shipbuilders in Scotland.—The volume of the "Transactions" of the Institution of Engineers and Shipbuilders in Scotland for November, 1917, contains the presidential address of Mr. [illegible] points, and includes comparative figures for different forms of steam machinery for purposes of navigation. A number of points of interest in turbine design are also dealt with, some curves being presented to show the effect of temperature on the tensile strength of mild steel, copper-manganese, Muntz metal and other materials. The latter part of the address is concerned largely with industrial unrest, industrial coordination and industrial reward. The volume also contains a Paper on "Premium Bonus Systems," by Mr. W. H. Riddlesworth.

Industrial Reconstruction Council.—The Lord Mayor will preside at the inaugural meeting of the Industrial Reconstruction Council, which is to be held on Friday, February 15th, at 3 p.m., at the Guildhall, London. Dr. Addison, Mr. G. H. Roberts, Lord Burnham, Mr. J. H. Whitley and other speakers representative of all industrial interests, will deal with the practical problems of industrial reconstruction. This is the first of a series of important meetings which the Reconstruction Council is arranging with the object of focussing public opinion upon the tremendous industrial problems that will arise at the end of the war. Applications for tickets should be made to the secretary, the Industrial Reconstruction Council, 8, Bouverie-street, E.C. 4.

An Address to Apprentices.—We notice in the "Railway Gazette" an account of an address given by Mr. K. Preston, electrical engineer to the North Western Railway, India, on the occasion of the opening of the electrical classes that have lately been started at Lahore. Mr. Preston referred to the great opportunities for the services of electrical engineers in India, though he agreed that preliminary experience in shops in England was desirable. In the course of his address he warned apprentices against assuming too complete a knowledge after finishing their course. In such a subject as electricity nothing but constant inquiry and study would enable a man to keep abreast of his profession, and one's training really continued right through a professional career. In India where resource and initiative are particularly necessary, the engineer must continually cultivate the spirit of inquiry, ask questions, and endeavour to learn all he can from those around him.

Chromium Steel for Magnets.—Owing to the commandeering of tungsten for military purposes, German electricians found themselves without tungsten for their magnet steels early in the war, and experiments on the use of chromium in the place of tungsten, which had already been projected before the war, were accelerated. According to "Engineering," the research has been conducted in the Reichsanstalt on behalf of the Verband Deutscher Elektrotechniker. The preliminary report, published by the Reichsanstalt in 1917, did not give particulars, which were, however, to be communicated to members of the Verband on inquiry. Krupp's works supplied 37 specimens of steel containing varying percentages of chromium and of carbon: they had been turned into rods and hardened in various ways in the works, and were then aged, after the method of Strouhal and Barus, by repeated heating, cooling and mechanical stress, while being tested at intervals in the Reichsanstalt. The unfinished investigation concerns also the temperature coefficient of magnetisation and the durability of the steels. It results that on an average chromium steels, which have undergone suitable heat treatment, do not rank below tungsten steels; the very best magnetic chromium steels, however, are not equal to tungsten steels. Technically, chromium steels would thus appear to be quite satisfactory, [illegible] special researches their further improvement is desirable.

Heat Calculations for Baking and Drying Ovens.—An article on this subject by W. S. Scott in the "Electric Journal" for November contains some useful data. As an example, the author works out a practical case, involving the enamelling of [illegible] lb. of sheet metal at 150 F. (max.), the material entering the oven at 70 and leaving at 500. The oven is assumed to be of the continuous type, the work being hung on the conveyor [illegible] automatically, while travelling, drained and conveyed continuously through the oven. The oven is 27 ft.

wide, 54 ft. long and 8 ft. 6 in. high, with insulated walls consisting of 4 in. of high grade insulating material. The conveyor travels at a speed of 6 ft. per minute and weighs 12 lb. per foot, giving a total weight of 4,320 lb. per hour. It will enter the oven at about 150 deg. and leave at 450 deg. 12,400 cubic ft. of ventilating air are used per hour, with a temperature rise of 380°F. The radiation loss area of the walls is 4,293 sq. ft., having a surface temperature of 100°F., and a radiation constant of 0·6. The total heat requirements per hour are :—

—	B.Th.U.	Kw.-hours.	Watts per unit.
Radiation	225,400	66·1	15·4 per square foot.
Conveyor racks	162,000	47·5	11·0 per pound.
Sheet metal load ..	287,500	84·4	8·44 per pound.
Ventilation	514,400	151·0	12·2 per cubic foot.
Total	1,189,300	349·0	

Absorption by the walls is not considered in a continuous type oven. In this special case, 156 heaters with a maximum demand of 360 kw., were necessary. This resulted in 28·7 lb. of material being baked per kilowatt hour.

Methods of Camouflage.—In a recent issue of "Nature" a brief account is given of various methods of "camouflage," which are applied to disguise hangars, houses and mercantile shipping, and are based on various quaint combinations of colours. This method, however, does not appear to have been a complete success. Another method, depending on what is sometimes called Thayer's law, seems more promising. Mr. Thayer, an American artist, was one of the first to recognise that a high degree of invisibility is conferred on certain birds by the simple adaptation of being dark above and whitish below. He took two wooden decoy ducks, and placed them against a sandbank. One was coloured like the sand, or coated with sand; the other was coloured on its upper parts darker than the surrounding sand, and graded below to pure white. At a short distance the first was still clearly visible, but the second was quite lost against its background. The first bird was revealed by the dark shadow below it; the second was made invisible because the light lower parts were neutralised by the shadow, while the dark upper parts were toned down by the strong direct light. The device has been tried on ships by differential painting, but this device has not proved so successful as had been hoped. On some other quite different line, it is said, the Admiralty has discovered a system of camouflage which will go far to baffle the eyes of submarines. This is essentially a scientific problem which deserves the effort of leading workers in optics as well as those of artists who appear to have been most successful hitherto.

Electrical Physics of the Atmosphere.—A Paper on the above subject was read recently by Mr. J. E. Taylor before the [illegible]

[illegible]

conditions conferring immunity from lightning effects, the functions of lightning rods and other protective devices were explained, and the standard methods of protecting telegraph and telephone lines were subjected to some criticism. Finally, an analysis was made of the vexed question of wireless strays and disturbances, and an account was given of the Dieckmann antenna screen. The Paper concluded with some account of magnetic storms and methods of recording meteorological data.

Obituary.

Andrew Walker.—Mr. Andrew Walker, electrical engineer, who recently left the employment of the Banknock Coal Co., to become chief engineer at Measham Colliery, Leicester, has been accidentally killed.

Personal.

Lord Rothermere has appointed Sir Henry Norman, M.P., to be an additional member of the Air Council.

Mr. M. C. Gilman, sales manager of the Toronto Electric Light Co. has been appointed secretary-treasurer of the Canadian Electrical Association, succeeding Mr. Alan Sullivan, who resigned recently to go overseas.

Military Honour.—The following military honour is announced: Major H. Richardson, general manager of Dundee electricity supply department, has been awarded the Military Cross. Major Richardson has been on active service in France since June, 1915, and, besides receiving the above decoration, has been twice mentioned in dispatches. He went out to France originally as officer commanding the local company of the Royal Engineers, but was promoted in September, 1917 to a much more responsible position there.

Arrangements for the Week.

FRIDAY, Feb. 1st (to-day).

Royal Institution.

5.30 p.m. At 21, Albemarle-street, London, W. 1. Discourse on "Gravitation and the Principles of Relativity," by Prof. A. S. Eddington, F.R.S.

Junior Institution of Engineers.

8 p.m. At 39, Victoria-street, London, S.W. 1. Paper on "Dynamics of Falling Bombs," by Mr. E. F. Etchells.

SATURDAY, Feb. 2nd.

London Association of Foremen Engineers.

7 p.m. At Cannon-street Hotel, London, E.C. Discussion on "A Scheme for the Encouragement of the Better Training of Lads in Engineering Workshops."

MONDAY, Feb. 4th.

Royal Society of Arts.

[illegible]

TUESDAY, Feb. 5th.

[illegible]

Snook Apparatus," by Mr. E. E. Burnside.

WEDNESDAY, Feb. 6th.

[illegible]

THURSDAY, Feb. 7th.

[illegible]

FRIDAY, Feb. 8th.

[illegible]

Telephone Exchange Transfers and Their Organisation.*

By F. G. C. BALDWIN.

Broadly considered, transfers may be effected in three ways, as follows:—

(a) By transferring each line independently.
(b) By transferring the subscribers in groups.
(c) By transferring the whole of the lines at one operation.

Method (a) possesses certain commendable features, but traffic considerations unfortunately preclude the adoption of this method. Method (b) has similar, although less, serious objections. Method (c) is the one usually adopted. From a traffic point of view, difficulties are reduced to a minimum; the actual operation can be carried out expeditiously—the time taken being measured in seconds—and a period can be selected for the change when it is known that the traffic will be at a minimum and when the least possible interruption to the service will ensue.

Line Plant Considerations.

The subscribers' lines to be diverted must be dealt with in such a way as to render each line available for simultaneous connection to the new exchange when the circuit is severed from the old. It will be necessary to instal new cable plant from the new exchange to one or more suitable points where the lines affected may conveniently be tapped. The following four methods are considered: (a) Lines teed underground; (b) Lines teed underground and overhead; (c) Lines teed at old exchange, which, generally speaking, is an undesirable method; (d) Lines diverted via new exchange. This last arrangement possesses decided advantages, and greatly simplifies and facilitates the operations to be performed both at the transfer and afterwards; but the cost of provision of the circuits between the old and new exchanges, for the purpose of accommodating the subscribers' services until they are transferred, increases with the distance between the two exchanges and unfortunately precludes the adoption of this method in every case.

Methods of Effecting Transfer.

The particular means adopted in accomplishing a transfer may, of course, vary according to the circuit arrangements which obtain and with the design of the apparatus concerned. The number of individual operations to be carried out may be very large indeed, running into many thousands. If the heat coils at the old exchange are withdrawn the exchange line will be disconnected there, and if the insulating separators between the spring contacts of the cut-off relay situated at the new exchange be thereafter removed the circuit will be at once thrown on to the new equipment, leaving the portion of the line between the teeing point and the old exchange as a tee upon the new circuit. It is essential that the withdrawal of the separators from the cut-off relays should not be attempted until all the heat coils at the old exchange have been removed.

The means adopted for the extraction of the heat coils must be such that the whole are removed within the space of a few seconds. [illegible] by means of two fairly strong tapes threaded behind the coils from top to bottom, one on each side of the strip, the two ends at top and bottom being bound together. If the bound extremities of the tapes be held, one in each hand, a fairly smart and extended pull will cause all the heat coils in the strip to spring out of their clips. Similarly, the insulators may be made with holes through which tapes are threaded.

In the original paper details are given of the Western Electric Co.'s type of combined line and cut-off relay, including a convenient form of [illegible] separator for insulating the relay contacts; [illegible] removing the separators are also described.

[illegible] it is preferable to treat each [illegible] and then effect only [illegible]

[illegible]

[illegible]

To effect transfer the following operations are necessary:—

(a) Withdraw heat coils from protectors of lines Nos. 1 and 2 at existing exchange, thus disconnecting both lines from the existing exchange equipment.

(b) Withdraw heat coils of temporary protector at new exchange, thus isolating the section of circuit between the two exchanges formerly used for line No. 1.

(c) Withdraw insulating plug in specially provided jack at old exchange, throwing line No. 2 on to its proper protector at the new exchange by means of the same pair of wires previously in use for subscriber No. 1 between the two exchanges.

(d) Withdraw separators in cut-off relays at new exchange.

To provide testing and other facilities two break jacks are permanently included in the circuit of each junction line at the exchange.

Preparatory Line Work.

Existing Plant Renewals.—Although the line plant of a magneto system may have been maintained in a satisfactory manner, sources of trouble may become apparent when central battery conditions are introduced. This system demands that the line plant should be maintained with a relatively higher standard of insulation. Fleeting troubles such as intermittent earths, contacts, and short-circuits of but little moment in the case of the magneto system must be eliminated. Therefore, when the change is from magneto to central battery it is advisable that the open line plant be overhauled and such weaknesses removed.

Fugitive line faults are not readily revealed by electrical test. In order to ascertain which lines need improvement in insulation, preliminary insulation tests may conveniently be made from the old exchange.

New Line Work.—In view of the peculiar troubles occurring in open lines associated with a central battery system, the proportion of open line plant should be limited. Therefore, when replacing a magneto by a common battery system, expense in substituting underground for heavy open lines is usually justified. Advantage may at the same time be taken of the opportunity to provide for future development. The new plant may take the form of extensions of an existing underground system, or an entirely new scheme of underground work may be embarked upon for an exchange area previously served wholly by overhead means.

Where the establishment of a central battery system is justified, it is generally economical to arrange an underground system with distributing points from which the subscribers' services are completed by means of small distributing cables underground or short sections of open wire. In this way the mileage of open line is minimised.

The work of installation of new ducts and cables may proceed while the exchange building is in course of preparation. The work should be so timed that the external cables are completed by the time the new main distributing frame is ready for use. The main cables may then be extended thereto, terminated, tested, and numbered out, and connected up to the main frame equipment.

Making Tee Connections.—The provision of tee connections in association with the transfer of a large exchange is a matter of considerable importance.

For a large transfer, the number of tee connections to be made may be considerable; it may be impracticable to avoid making a large number of tees at one or more points on the underground cable system and to distribute them over a number of lesser points; several large cables may be involved at one point and, as the number of pairs of wires to be dealt with increases, so are the difficulties multiplied.

The small gauge wires (6½, 10, and 12½ lb. per mile) on large cables (600 and 800 pairs) commonly used in modern telephone systems demand exceptional care.

The period during which the tees must be maintained is usually protracted, during which it may be necessary to undertake:

(a) Testing in connection with the localisation of faults;

(b) Introduction of additional teed connections necessitated by the provision of new services;

(c) Alteration to existing teed connections owing to removals, cessations, &c., of subscribers' services.

Where large cables are concerned, the number of the insulated conductors may be so great as to preclude the whole being encased by plumbing work, and other steps must therefore be taken to maintain the exposed paper core cables in a perfectly dry state.

Cast iron cable boxes have been utilised in an attempt to facilitate hermetical closure of the cable and to provide ready means of access to the tee connections. If such a measure be adopted, it is still desirable that the wires should be waxed and bound in order that they may satisfactorily withstand any handling to which they may be subjected.

When the line arrangements for transfer admit of the tees being made within the new exchange the serious difficulties introduced by external teeing points are entirely removed. Tee connections can conveniently be made at the main distributing frame of the new exchange.

PREPARATORY WORK AT SUBSCRIBERS' STATIONS.

If the electrical operation of the new exchange be similar to that of the old exchange no modifications to the apparatus at the subscribers' stations will be necessary.

For exchanges of 500 lines and upwards, the magneto-calling local battery system has now given place to the more modern central battery system. The displacement of the magneto generator and primary batteries at the subscribers' station renders a complete change of apparatus desirable although not absolutely necessary.

The following three alternatives for treatment of subscribers' installations are presented :—

(*a*) Fix new central battery apparatus alongside the old and provide a change-over switch to be operated by the subscriber at the time of transfer for changing over to the new apparatus. This method is to be deprecated in consequence of increased cost, restricted accommodation for apparatus, and possible trouble by mis-operation of the switch by the subscriber.

(*b*) Modify existing apparatus to permit of central battery working until the modern central battery apparatus is installed after the transfer.

It will usually be economical and convenient to adopt this alternative in cases of subscribers' simple sets and at stations with only one extension. Replacement of the old instruments by modern central battery apparatus may be carried out and full central battery conditions established as convenient after the transfer.

(*c*) Install new central battery apparatus prior to the date of transfer, introducing the modifications necessary to provide for satisfactory working until the transfer has been made.

This method is recommended for installations with switchboards where displacement of the old apparatus has been decided upon. It possesses the important advantage that the work to be done after the transfer is reduced to a minimum.

In order that the magneto apparatus comprising subscribers' installations may be made to conform to central battery working attention should be given to the following points:—

(*a*) *Insertion of Condensers.*—To maintain an open circuit when the receiver is hung upon the switch-hook condensers of 2 mfd. capacity are inserted at the following points :

1. Bell circuit of subscribers' single instrument installations.
2. Bell circuit of extension instruments.
3. Bell circuit of extension switches.
4. Circuits of extension bells joined direct across lines having connection to exchange.

(*b*) *Insertion of Holding Coils.*—To guard against premature clearing signals being given at the exchange from private branch exchange installations not replaced by central battery apparatus prior to transfer, it may be necessary to provide "holding coils" which may be brought into circuit with the exchange line, when engaged, during the time the operating instrument is utilised in speaking to an extension station.

(*c*) *Polarity of Receivers.*—It is necessary to ensure that the receivers of all instruments are connected in such a way that the current received over the line from the central battery will augment rather than reduce the magnetism of the receiver magnet.

(*d*) *Internal Wiring.*—The internal wiring should be tested for insulation and [illegible] and any observed defect remedied. Alterations to [illegible] point is being changed should also be provided for.

PREPARATORY WORK AT OLD EXCHANGE.

In ordinary cases the work to be carried out at the existing exchange prior to transfer [illegible]

[illegible]

[illegible]

[illegible]

As the work at each subscribers' station is completed, tests from the exchange in conjunction with the fitter are made to ascertain—

(*a*) The insulation of the circuit.
(*b*) Whether condensers have been fitted at the requisite points.
(*c*) Whether the receivers are connected correctly.
(*d*) Whether the circuit is working satisfactorily.

PREPARATORY WORK AT NEW EXCHANGE.

When the installation of the new exchange equipment is sufficiently advanced, the work which has to be done there in preparation for the transfer may be taken in hand.

As advice is received from the jointer of the circuits shunted into the exchange, the procedure recommended below in connection with each line may conveniently be followed by the test clerk—

(*a*) Verify that the main distributing frame cross-connection is already joined up to the correct exchange number.

(*b*) Remove heat coils from protector of respective line and insert fuses on main distributing frame.

(*c*) Test out line and confirm the subscriber's telephone number.

(*d*) From the cable distribution schedule check off circuit as "available at new exchange" and insert the necessary entries in all records concerned.

(*e*) Advise the test clerk at the old exchange of the tee connection having been made.

(*f*) Advise the jointer when each group of lines with which he is concerned has been dealt with.

Private lines, extension lines, and other lines which will merely pass through or via the main distributing frame should be diverted permanently and cut out of the old exchange. At the time of transfer only lines actually operated at the old exchange will then be left to be transferred.

By the time the test-room equipment is ready the test clerk should be in possession of lists showing the distribution of subscribers on the calling equipment of the new switchboard.

When the work of diversion is sufficiently advanced and the new central battery switchboard completed, instrument fitters should make a final visit to the subscribers' stations before the transfer.

FINAL PREPARATIONS.

It is desirable that the final arrangements should not be commenced earlier than is essential.

The work to be carried out is as follows :—

(1) *Final Tests of Subscribers' Lines.*—These are made at the test desk of the new exchange and may occupy several days, depending upon the number of lines to be tested and the number of testing officers accommodated. Each circuit to be transferred is proved to ensure that

(*a*) The insulation and conductivity of the line are satisfactory.
(*b*) Each subscriber is connected to the correct exchange equipment.
(*c*) The condenser is in circuit.
(*d*) Speaking is satisfactory.

(2) *Final Tests of Junction Circuits.*—Each junction circuit to be transferred requires to be finally tested under actual working conditions between the new exchange and the distant exchange.

All junction circuits duplicated for the transfer should be similarly tested and left in working condition.

(3) Relay tests. (4) Line fuse examination. (5) Heat coil test. (6) Lightning arrester test. (7) Special temporary arrangements. (8) Meter readings.

(9) On or before the evening of the day prior to the transfer, attention should be given to the following details :—

(*a*) [illegible] coils on main frame at old exchange.

(*b*) Insertion of separators between the spring contacts of cut-off relays.

(*c*) Insertion of [illegible] distributing frame. [illegible]

(10) [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

line the removal of heat coils at old exchange and waits for advice that this has been accomplished.

(*b*) On receipt of this intimation, the test clerk gives pre-arranged signal to :—

1. Extract separators from cut-off relays, and
2. Withdraw remainder of plugs in junction test-jacks.

(*c*) The exchange supervisor and the test clerk at old exchange are then advised that the transfer has been accomplished, and the officer deputed to carry out relay tests is directed to proceed.

(*d*) The test clerk at old exchange informs supervisor there that transfer is completed.

TRAFFIC AND OPERATING CONSIDERATIONS.

Choice of Day and Time for Transfer.—Traffic conditions must be taken into account in selecting a day and time for the transfer operation.

The choice of the least busy period is particularly helpful in the transfer of junction lines.

Switchboard Distribution of Subscribers' Lines.—In order to secure uniformity of attention to calls it is necessary to distribute subscribers' circuits over the answering positions of the switchboard not in numerical order, but in relation to their traffic activities. Such distribution must of course be based upon actual observation of conditions obtaining for each subscriber's line.

Programme.—A programme of instruction for the guidance of the operating staff concerned in the transfer should be drawn up in order that no essential detail be overlooked.

Training of Operators.—Operators who are to be transferred from the existing to the new exchange should be familiarised with the working and local conditions of the new board in advance of the transfer.

Operating Procedure.—The operating arrangements to be made in connection with a transfer will, of course, vary with different conditions, but the author describes a typical form of procedure.

Subsequently the arrangements involved in post-transfer work, which include removal of tees, final cable operations, dismantling old exchange, and change of apparatus at subscribers' installations, are dealt with.

To secure the most economical and efficient results in connection with a transfer of material dimensions, careful organisations of the whole of the work involved is obviously necessary.

From the point of view of economy, it is particularly essential that the various sections of work should be co-ordinated in such a manner as will preclude delay being caused to any section of the work by non-completion of any other section within the requisite time.

It is, of course, not possible to stipulate here the sequence of operations, because each case will vary in its requirements, but in the original paper a table is given exemplifying the order in which [illegible] operations may best be conducted. Those works which may proceed simultaneously are distinguished and a [illegible] of predetermined dates by which [illegible]. A programme prepared on these lines [illegible] to the responsible engineer and an aid in [illegible].

[illegible] such as new subscribers' services, removals, and other work of a similar character, [illegible] possible.

[illegible]

[illegible]

The positions to be manned for the transfer operation will be generally as follows :—

(*a*) Old exchange test desk.
(*b*) Old exchange main frame.
(*c*) New exchange test desk.
(*d*) New exchange main frame.
(*e*) Relay racks.
(*f*) Each exchange connected direct by junction lines to the exchange to be transferred (unless the lines concerned have been duplicated).
(*g*) New exchange faultsman.
(*h*) New exchange testing operator's position.
(*j*) Line fault control.
(*k*) Subscribers' apparatus fault control.
(*l*) Underground teeing points not closed in.
(*m*) Construction staff for removal of tees, if required.

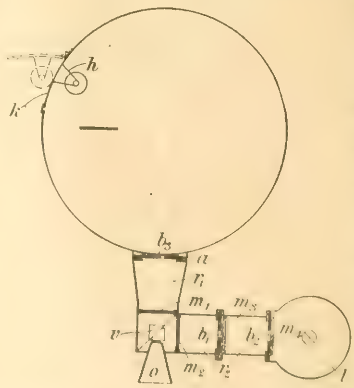
It is advisable that complete control of the transfer operation should be vested in one individual situated at one recognised point of vantage. The most suitable position will no doubt be at or in close proximity to the test clerk's desk.

A New Globe Photometer for Incandescent Lamps.*

By R. VON VOSS.

The advent of the half-watt lamp has given rise to the need of a photometer, by which mean spherical candle-power can be easily measured. The instrument to be described is of the type known as the Ulbricht Globe Photometer, modified in such a manner as to render its use more rapid and convenient. The figure gives a view in plan of the general arrangement.

The globe is formed of two hemispheres of 1 m. diameter pressed out of zinc sheet, and is provided with a hinged door at k that carries the supports for the lamp under test. The globe is suitable for use with lamps with bulb diameters up to 13 cm., which would include lamps up to about 300 watts or 500 m.s.c.p. For lamps of 20 cm. diameter of bulb a globe of 1·5 m. would be required.



At the same height as the door a round opening is made in the globe provided with a tubular projection r_1, closed by a sheet of ground glass m_1.

The ground glass screen m_2, that is viewed simultaneously with m_1, through the photometer v, receives its illumination through the ground glass screens m_3 and m_4 from the comparison lamp (marked l and with a cross). The measurement is by equalising the illumination on the screens m_1 and m_2. This is effected by an adjustable wedge-shaped opening b_1 worked by a rack and pinion, the area of the opening of the slit being read off on a scale that is provided. As m_3 is illuminated uniformly the illumination on m_2 is proportional to the area of the opening at b_1. In order to make the instrument direct reading a second slit b_2 is provided. If now a calibrated lamp is inserted in the globe, the slit b_1 may be adjusted so that its indicating scale reads the candle power directly and the opening of b_2 is adjusted until balance is obtained in the photometer. b_2 is now left in the position thus found and the adjustment of b_1 for any other lamp will give a direct reading of its candle power. Various circular stops may be inserted at b_3 to alter the range of the instrument, and the use of stops enables direct readings to be made on the scale b_1, in multiples of 10, from 2·5 to 750 mean spherical candle power.

* Abstract of an article in the "Elektrotechnische Zeitschrift," No. 14, 191[illegible].

Electric Ploughing.*

By A. DELAMARRE.

(*Concluded from p.* [illegible].)

The Fillet System.—While the German firms have aimed at powerful and heavy mechanism, M. Fillet has endeavoured to obtain equally good results with light engines. The Fillet winch weighs 4,000 kg.–6,000 kg. for horse-powers between 45 and 80, [illegible]

[illegible] [illegible] the Siemens type, weighing 13 tons, and utilising a motor of 80 H.P. and a tractive force of 4,000 kg. It has been developed too recently for one to appraise its value in practice, but deserves notice.

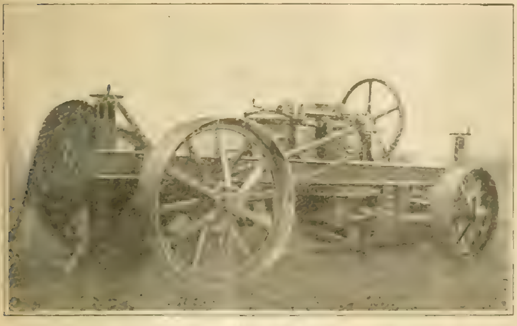


Fig. 7.—Fillet Winch with Anchor-Plate.

Fig. 8.—Fillet W[illegible]

and permits a tractive force of 4,000 kg., the same as that achieved in the Siemens system, but with a third of the weight. The electric motor engages direct with the winch by means of gearing, the carriage being [illegible] by means of [illegible] Fig. 7, or by pulling on a [illegible] to an anchor 200 m. away. The lightness of the [illegible] is such that it could not alone resist the pull of the plough, and therefore, an anchor plate [illegible]

Comparison of Systems.

The design of the heavier types is based on the assumption that only in this way can one secure sufficient resistance to ensure firm anchorage. On the other hand it may be argued that if the surface presented at the winch-carriage exceeds that of the plough, sufficient anchorage will be available. [illegible]

Fig. [illegible]

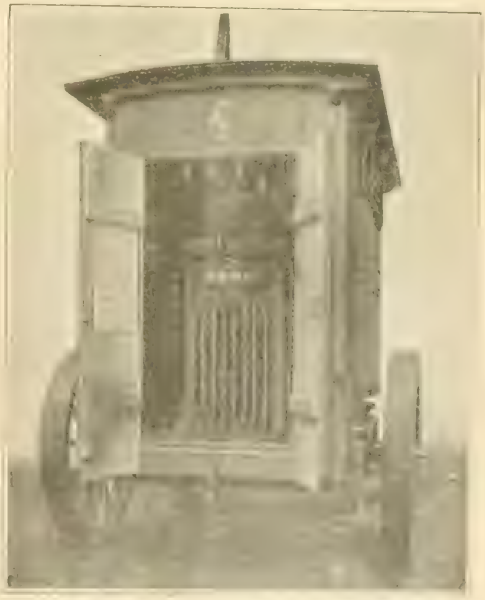


Fig. [illegible]

[illegible]

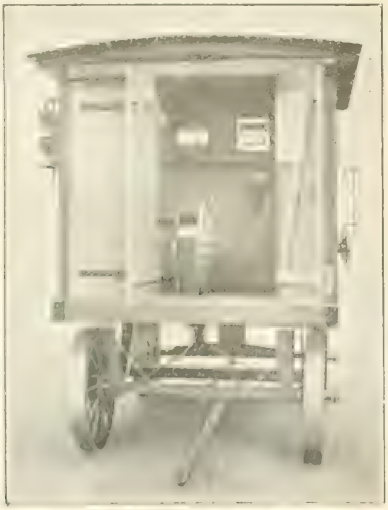
* [illegible]

[illegible]

requiring solution. The power of the motor (60–80 H.P.) implies a pressure of at least 500–600 volts, which, with reasona'le caution on the part of labourers, is not excessive from the safety standpoint. But this pressure can only be used to facilitate the removal of the

FIG. 11.—TRANSFORMER VEHICLE (SIEMENS) LOW-TENSION SIDE.

motor from the transformation centre, the power being initially [illegible] high-tension lines. It is at this point that the difficulties begin, for the provision of detachable connections to high-tension wires, without danger to life or danger of short-circuit, is a delicate matter.



[illegible]

[illegible]

and to take precautions that the connection can never be broken until this interrupter is open.

On the other hand the movable transformation carriage presents few difficulties. Fig. 10 shows the Siemens transforming house, and Fig. 11 enables the low tension side of the system to be seen. In Fig. 12 the transformer-carriage also contains a drum on which the low-tension flexible connector can be conveniently wound.

Another point that requires consideration is the support of the cable when in use. If allowed to trail over the ground its outer surface inevitably suffers, and sooner or later it is damaged by the plough passing over it. A better method is to support it on portable short posts. In Fig. 13 a series of such supports are seen, being conveyed in a cart drawn by oxen.

COST OF ELECTRIC PLOUGHING.

While the nature of the soil and other factors enter into the problem one can reckon on a consumption of about 79 units per hectare, and a daily treatment of about 4 hectares. Assuming that current is obtainable at 0·2 fr. per unit, this involves a daily expenditure for power of about 60 fr. The wages of an electrician, working the carriage, and a labourer attending to the plough will amount to another 20 fr. per day. The total costs of an installation, adapted to an area of 350 hectares may amount to 100,000 fr., the interest on which may be taken at 15,000 fr. This works out to

FIG. 13.—PORTABLE SUPPORTS FOR CABLE BEING CARRIED IN CART (FILLET SYSTEM).

43 fr. per hectare, while, assuming that 4 hectares are ploughed per day the cost of current and wages will come to (60+20)/4 or 20 fr. The total cost per day per hectare is thus about 63 fr. In favourable circumstances this may be brought down to 50 fr. per hectare per day, which, in spite of the heavy initial cost, is lower than can be expected by using steam or hand-labour.

While 700–800 hectares per year might be worked by electrical ploughing, at least 300 hectares should be treated in order to render electrical methods economical. The high initial cost, which is one of the great obstacles, can be met to some extent by co-operative means. The development of electric ploughing also involves either wider distribution of electricity in agricultural districts from the supply company's network or the establishment of local stations by agricultural interests. The chief problem of the future is to convince the farmer that expenditure on electrical development pays.

Aero - Steam Railway Traction. — According to the *Engineer* the French Institution of Civil Engineers has been devoting itself to aero-steam traction, a report on this subject being presented by M. Giradon. It is remarked that if firing is stopped on a railway locomotive or is continued with good dry coke, and the cylinders are subsequently supplied with compressed air from reservoirs carried on the tender or from a special compressed air tender, this "aero-steam" will continue to run the train for some time without the emission of smoke or steam. The exhaust vapour from the cylinder is condensed by the cooling effect of the expanding compressed air. It is suggested that this device would be useful in passing through tunnels where the emission of smoke or steam would be objectionable, on heavy grades where it is desired to augment speed, and on metropolitan or suburban lines where there are frequent stops and rapid acceleration is desirable. As an instance of a case where the method would be useful, the tunnel [illegible] through the Ural Mountains is mentioned.

Notes on the Design of Electromagnetic Machines.*

PART III.

DESIGN OF AN ALTERNATING-CURRENT TURBO-GENERATOR.

By STANLEY PARKER SMITH, D.Sc.

(Continued from page 82, vol. LXXX.)

Summary.—In Part I. of the article the author deals with some of the main principles underlying the design of alternating-current generators. In Part II. these principles are applied to the design of a low-speed, three-phase alternator, giving 750 kw. at 2,200 volts when running at a speed of 250 revs. per min. In Part III. a three-phase turbo-alternator is designed to give 2,000 kw. at 3,000 revs. per min. at a line pressure of 500 volts, and the mechanical stresses in the rotor are discussed.

We shall choose a low terminal pressure, in order to bring out some of the difficulties met with in high-speed machines.

One of the most important parts of the design of turbo-alternators is the arrangement of the ventilation. In all modern designs these machines are totally enclosed, not only to reduce the noise and the windage losses but largely because this is necessary to ensure that the cooling air passes along pre-ordained channels. In general, there are two distinct schemes of ventilation in use, which are commonly known as axial and radial, from the general direction in which the air flows. In many machines the two schemes are combined. In the axially-ventilated machine the air simply enters at one end, flows along a number of axial holes or ducts in the stator and rotor cores, and along the air-gap, and leaves at the other end, the overhang of the stator winding being cooled as the air passes through the respective air chambers at the ends of the machine. When radial is combined with axial ventilation, a common arrangement is for the air to enter at each end, and after playing on the end windings pass into the air-gap, where it meets other air drawn through axial and discharged through radial ducts in the rotor; the air then leaves the gap through a large number of radial ducts in the stator.

In addition to the pure axial ventilation and the combination of axial and radial ventilation in the simple manner thus described, there are many other arrangements that need not be discussed here. For a description of such methods, the reader should consult Miles Walker's book, &c. In general, it may be said that the use of axial holes in the stator leads to a larger external diameter of the machine, whilst the use of radial ducts leads to an increase in the axial length of the machine. The fans needed to force the air through the cooling channels may either be inside the housing of the machine (internal fans) or outside (external fans). The former practice is more usual.

In the present case we shall design a machine with pure axial ventilation (see the drawing, Fig. 1?), and the fans needed to drive the air through the machine will be fixed on the rotor. The larger fan is called the stator fan and supplies the air for cooling the stator winding and core; the small fan is called the rotor fan and drives air through the axial ducts of the rotor.

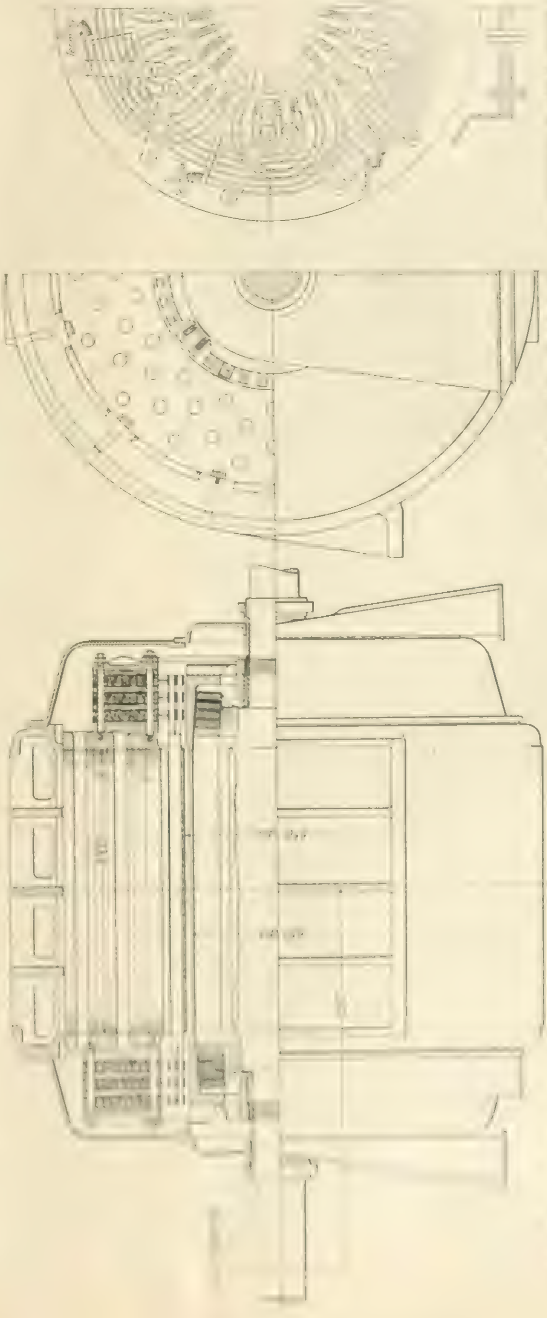
Three-phase Turbo-generator.

Output: 2,000 kw. at [illegible].

Line pressure: 500 volts with phases joined in star.

Speed: 3,000 revs. per min.

Frequency: 50 cycles per second.



[illegible] 2,000 kw. [illegible] 500 volts, 50 cycles; 3,000 revs. per min. [illegible] (All dimensions in millimetres.)

* The first part of the article [illegible] Current Machines, and the first part of the present, appeared in THE ELECTRICIAN of June [illegible], 1916 (Vol. LXXVII., p. [illegible]).

Guarantees.

Temperature rises : To be in accordance with the rules laid down by the Engineering Standards Committee, and only mica or other non-combustible material to be used for the insulation of the rotor and stator windings.

Efficiency and regulation at unity and 0·8 power factor to be stated.

Wave Form : To be sinusoidal under all conditions of load, and free from tooth ripples.

Method of Procedure.

The calculations will be arranged in the following manner, though it may not be possible to carry them out strictly in the order given.

1. Main dimensions.
2. Stator.
3. Calculation of open-circuit characteristic.
4. Rotor.
5. Calculation of heating.
6. Efficiency.
7. Mechanical calculations.

1. Main Dimensions.

We first find the output, pressure and current per phase :—

Output of machine $=2{,}000/0{\cdot}8=2{,}500$ k.v.a.

Output per phase $=2{,}500/3=833{\cdot}3$ k.v.a.

Pressure per phase : [illegible] 289 volts.

Current per phase : $I_p=2{,}900$ amperes.

Revolutions per second : $n=3{,}000/60=50$.

Number of poles : $2p=2f/n=2$.

For the *specific electric loading* we can take

$$ac=\frac{ZI_a}{\pi D}=250 \text{ ampere conductors per cm.,}$$

and for the *specific magnetic loading* :

$$B_{mean}=\frac{\Phi}{Y L}=1{,}500$$

a rather higher value than would be assumed if radial ducts were present. (For symbols, *see* Part II.)

With these preliminary values, the output coefficient will be (see Eq. 15, Part I.) [illegible]

$$C=\pi^2 K B_{mean}\, ac\, 10^{-8}$$
$$=[illegible]\ 1{,}500\ 250\ 10^{-8}=11{\cdot}75.$$

$$\text{Hence } D^2L=\frac{KVA\ 10^3}{C\,n}=\frac{2{,}500 \cdot 10^3}{11{\cdot}75 \times 50}=425{,}000.$$

[illegible] it is easy to split up D^2L, [illegible] D [illegible] peripheral speed. In [illegible] to steam turbines, [illegible] lies between [illegible] rotor pole [illegible] peripheral speed [illegible]

[illegible]

2. Stator.

The rotor will consist of a solid steel forging, into which slots will be cut for the exciting winding. Since there are no radial ducts in the machine, the iron length of the solid rotor is equal to the total core-length.

In the case of the stator, the large radial depth of the core and the absence of radial ducts necessitate great care in insulating the plates from one another. For this reason, we have taken the insulation coefficient as low as 0·87.

(*a*) *Stator Winding.*—A characteristic feature of the turbo-alternator is the large flux per pole. Thus in the present case with $B_{mean}=1{,}500$, $\Phi=YLB_{mean}=102\times 100\times 1{,}500=46\times 10^6$ lines per pole. Hence the E.M.F. induced in one turn is usually very large, and in this machine will be $E=kfT\Phi 10^{-8}$ $=4{\cdot}24\times 50\times 1\times 46\times 10^6\times 10^{-8}=97{\cdot}5$ volts ; so that with the low pressure of 289 volts per phase, we only need $289/97{\cdot}5=3$ turns per phase.

On the other hand, the current per phase $I_p=2{,}900$ amperes is large, and it is well, if possible, to have a smaller current per conductor to keep the dimensions of the latter within reasonable limits, on account of eddy currents. Experience shows that a suitable value for the number of ampere-conductors per slot in turbo-alternators lies between 1,000 and 2,000. Thus, it will be best to have two parallel circuits per phase, in order to bring down the current per conductor to $I_a=I_p/2=1{,}450$ amperes.

To do this, it is only necessary to use a six-phase winding, and connect opposite pairs of phases in parallel. In pass on it may be mentioned that the use of a six-phase windinging, two-pole turbo-alternators is quite common, even when only one circuit per phase is needed, owing to the better arrangement of the overhang in three planes, *see* Fig. 4 (*B*) to (*D*.) In the present case where the two poles are joined in parallel, the further advantage is obtained of doubling the number of slots, which makes a better design for both the iron and copper parts of the stator.

With three turns per phase in series, one conductor per slot and two poles in parallel, the total number of stator slots will be : $S=(2TN)2=2\times 3\times 3\times 2=36$. The winding, of course, belongs to the single-layer class, with the connections as shown in Fig. 4 (*C*).

For the *stator winding*, then, we have the following particulars :

Type of winding : Six-phase, single-layer, with two circuits per phase (two poles in parallel).

Number of slots : $S=36$.

Number of slots per pole and phase : $q=S/2pN=6$.

Number of coil-sides per slot : $u=1$.

Number of turns per coil : $T_c=1$.

Number of turns per phase in series : $T=3$.

Current per path : $I_a=I_p/2=1{,}450$ amperes.

Ampere conductors per slot : $AC/\text{slot}=I_a u=1{,}450$.

Stator slot-pitch : $y_s=\pi D/S=204/36=5{\cdot}67$ cm.

Specific electric loading : $ac=(AC/\text{slot})/y_s=256$.

(*b*) *Stator Slots.*—The permissible current density in the stator copper depends on the means taken to reduce eddy losses and on the cooling properties.

[illegible] the eddy currents [illegible] the saturation of the stator teeth is mostly too low to cause any appreciable part of the main flux to go through the slots unless the distortion [illegible] considerable. To keep down the eddy losses due to the leakage flux, the conductors should be made shallow and the number of conductors per slot small. The loss due to this [illegible] has been investigated by M. B. Field, and a set of curves [illegible] given in Part II., Fig. 11. [illegible] while [illegible] is decreased as the cross-section of the conductor is increased, the eddy current loss in a very deep conductor may become inordinately large.* [illegible] to avoid deep conductors.

* [illegible] Vol. II of the "Archiv für Elektrotechnik," formulae are developed for finding the copper depth to give minimum loss.

or to use compressed strand, and the skill of the designer must be exercised to obtain the arrangement which will give the least loss, due consideration being given, of course, to cost and practice in the shops.

With regard to the cooling [illegible] depends on the type of machine. In slow-speed machines with short cores, much of the heat generated in the slot copper flows into the overhang and is there dissipated. In turbo-alternators, however, where the core is usually very long, most of the heat developed in the copper at full load is conducted through the insulation to the surrounding iron, and is carried off by the cooling air flowing along the ventilating channels. In a high-voltage machine, where the insulating wall may be 3–5 mm. thick, the temperature drop from copper to iron may be as much as [illegible], so that it becomes necessary to keep the loss per unit length as small as possible.

In the present machine, there is only one conductor per slot, but as this has to carry [illegible] amperes at [illegible], it is safest to use stranded copper. Even with strand, it is not advisable to trust too implicitly in the stranding being perfect, and the conductors should be kept as small as practicable. Partly for this reason and partly to obtain a narrower slot, the conductor has been split into two equal parts separated from one another by a strip of mica paper, as shown in the drawing (Fig. 18A). The two parts are not joined at the ends, but crossed in the overhang, so that the upper part in one slot is joined to the lower part in another slot to equalise the E.M.F.'s.

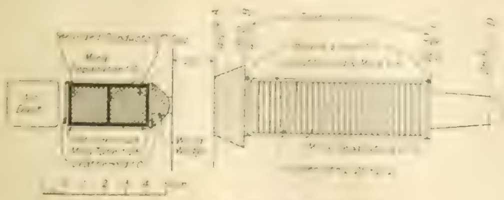


FIG. 18A.—[illegible] ROTOR SLOT.

With stranded conductors, the actual cross-section of copper varies from 75 to 85 per cent. of the total cross-section. Taking a mean value of 80 per cent., the current density in the conductor used, made up of two compressed cables, each 17 mm. square, will be [illegible] amperes per mm². As just stated, [illegible]

[illegible]

Total width = 22·0 mm.

[illegible]

tension machines. The leatheroid liners are merely used as a mechanical protection for the mica tubes during winding, and are not relied upon for insulation.

To reduce the gap reluctance, the slots are made semi-closed (8 mm. opening); whilst a cooling duct 22 mm. wide and 25 mm. deep is placed immediately behind the slot (*see* Fig. 18A), thus making the total tooth depth = 8 cm.

(*c*) *Overhang of Stator Winding.*—[illegible] winding has to be securely braced owing to the great stresses set up when a sudden short-circuit occurs. Sometimes the overhang copper is stranded like the slot copper, and in this case the coils are formed with an open end which is bent and joined up when the coil is in position, thus necessitating one joint per turn. Another arrangement, and the one we shall use in the present design, is to make the overhang of solid copper, suitably laminated to reduce eddy currents. With this construction, care must be taken to make good joints between the slot and overhang copper. The latter consists of eight straps for each conductor, the straps from the lower part in one slot being taken to the upper part in another slot, as shown in Fig. 18.

Owing to the good cooling of the overhang and the need to keep the section small to reduce eddy currents, we shall work the copper at a current density of 4·5 amperes per mm². Taking 4·5 amperes per mm²., the cross-section of an overhang conductor will be 1,450/4·5 = 320 mm². Dividing this into eight strips each 16 × 2·5 = 40 mm²., we get the required section.

(*d*) *Resistance of Stator Winding.*—The resistance of the stranded and solid parts will be calculated separately.

Stranded copper :—

Mean-length of one conductor = 100 + 2 × 18 = 136 cm.
Total length in series = 136 × 6 = 816 cm. = 8·16 m.
Total cross-section in parallel = 2(2 × 17² × 0·8) = 925 mm².

Hence resistance per phase [illegible]

Solid copper :—

Mean length of one conductor = 170 cm.
Total length in series = 170 × 6 = 1,020 cm. = 10·2 m.

Total cross-section in parallel [illegible]

Hence resistance per phase [illegible]

The total resistance per phase, *i.e.*, between a terminal and the neutral point, will be [illegible]

[illegible]

the mechanical and excitation losses. The loss thus measured on short-circuit represents the ohmic loss in the stator winding plus the stray loss, wherever the latter may occur, and in a three-phase machine may easily equal two to four times the pure ohmic loss produced by the same continuous current sent through the winding when cold. The question arises, however, whether the stray loss on short-circuit is the same as under working conditions. There are reasons for believing that a part of the short-circuit loss is not present on load, but for want of evidence to the contrary and to be on the safe side, it is advisable to assume that the whole of this loss does occur on load, and so provide a margin for additional load losses due to flux distortion, &c.

In the present case we shall take all stray losses into account by assuming the total loss due to the stator current on load, when the machine is hot, is equal to three times the pure ohmic loss when the winding is cold. Thus for the stator copper loss we have :—

Stator copper loss$=3(3\times 2{,}900^2\times 0\cdot 00043)10^{-3}=32$ kw.

(*g*) *Reactance of Stator Winding.*—To find the stator reactance we estimate the leakage flux in the same way as for the slow speed machine, by aid of equations 9 and 10.

For the slot leakage flux, we have :—

$$\lambda=\frac{35}{66}+\frac{4}{22}+\frac{2\times 8}{22+8}+\frac{2}{8}+\frac{20}{56\cdot 7}=1\cdot 9,$$

whence, for $T_c=1$ turn per coil :—

$\Phi_s=3\cdot 55\,I\,T_c L_0\lambda=3\cdot 55\times 1{,}450\times 100\times 1\cdot 9=1\cdot 0\times 10^6$

For the overhang flux (taking $k=3\cdot 0$) :—

$$\Phi_o=kIqT_cL_o=3\cdot 0\times 1{,}450\times 6\times 206=5\cdot 3\times 10^6.$$

Thus the total leakage flux $\Phi_a=\Phi_s+\Phi_o=6\cdot 3\times 10^6$.

The normal flux $\Phi=45\cdot 5\times 10^6$, *see* Section 3 (*d*) ; hence :

Inductive drop due to slot leakage $=1\cdot 0/45\cdot 5=2\cdot 2$ per cent.

Inductive drop due to overhang leakage $=5\cdot 3/45\cdot 5=11\cdot 6$,,

Inductive drop in stator winding $=6\cdot 3/45\cdot 5=13\cdot 8$,,

or, say, $14\cdot 0$,,

(*To be continued.*)

Comparative Experiments on the Audion.*

By G. VALLAURI.

The author gives an account of experiments made with five samples of the audion, with the object of determining their relative behaviour as amplifier, generator, and detector for the purposes of radiotelegraphy. Fig. 2 shows the electrical arrangement for [illegible] each of the arrangements. Here *PCK* is the audion, *P* being a plate anode, and *C* an intermediate grid electrode which may be positive or negative with respect to the kathode *K*, a filament [illegible] [illegible] *C* and *K* [illegible] between *C* and *K* being [illegible] between [illegible] and [illegible] by means of a [illegible] control [illegible] volts, which produces the current i_a in the anode circuit *PK*, the P.D. v_a between *P* and *K* being measured by means of the voltmeter [illegible].

The five samples of audion are not described in detail, neither is their origin given, but they are designated throughout by the numbers 1, 2, 3, 4 and 5.

Incandescence of the Kathode.—Owing to the difficulty of measuring

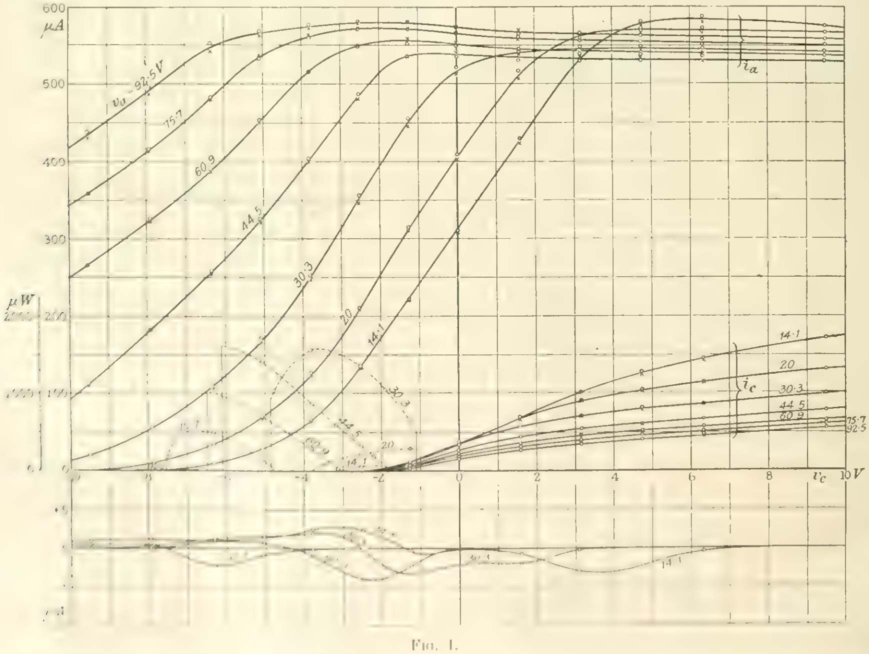


Fig. 1.

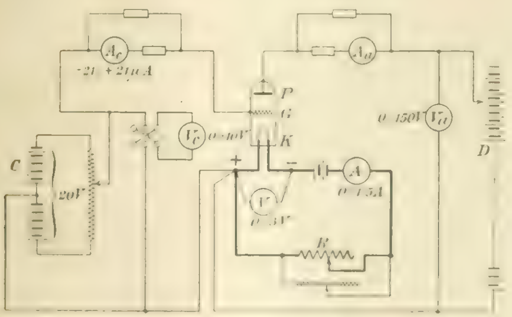
the intrinsic luminosity of the filament, the constancy of temperature is obtained by maintaining constant the ratio of the resistance of the filament when hot, to that when cold. Thus, for the five samples, the ratio (R/R_0) has the value 8·2, 8·9, 7·9, 8·2 and 8·8 respectively, when the intrinsic luminosities are approximately the same, and these values are maintained throughout all the experiments by regulating the current in the filament by means of the rheostat *R*.

[illegible] Characteristic.—The important property of the audion is that with constant P.D. (v_a) between *P* and *K*, the current (i_a) in this circuit varies enormously with the "control current" i_c. With v_a fixed in value, and employing the arrangement of Fig. 2, i_c is made to vary between −10

* [illegible] "L'Elettrotecnica," [illegible] 1917.

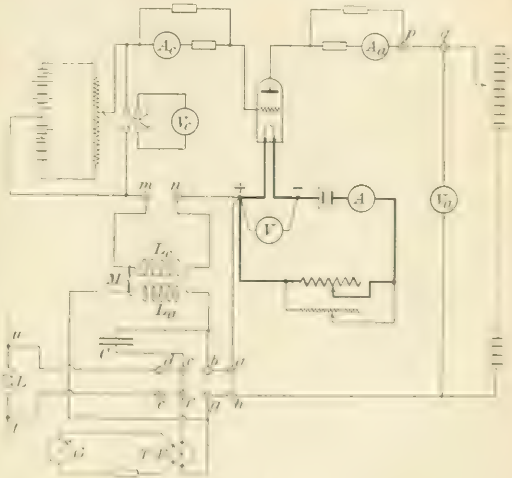
and 10 volts and back again, and the values of i_a as ordinates are plotted against the values of v_c as abscissæ. The curves obtained are called the *static characteristics* of the respective audions. The static characteristics are therefore families of curves, each curve corresponding to a particular value of v_a. The five audions give similar characteristics, but the scales differ, and those for Nos. 1, 2 and 5 are much more regular than those for Nos. 3 and 4. In Fig. 1 the static characteristics for No. 1 audion are given. It will be seen that i_c is very nearly uni-directional, and that i_a is a considerable magnification of i_c. There is very little "hysteresis" in the curves for Nos. 1, 2 and 5, the ascending and descending branches being nearly coincident; but for Nos. 3 and 4 this is not the case, the descending branch lying below the ascending branch, but the mean curves only are drawn. The amount of hysteresis is not, however, independent of the speed with which the cycle is performed. On reaching any point of the cycle and suddenly stopping, there is a creep, similar to the change occurring if viscosity were present. Also the amount of hysteresis is greater, the greater the slope of the characteristic.

The Audion as Generator.—With the two circuits of the audion magnetically coupled, electrical oscillations occur in a circuit consisting of an inductance L_a and a condenser C, in parallel with the plate or anode circuit, for certain values of the current i_c in the grid or control circuit. The magnetic coupling is effected by means of two inductances L_c and L_a (Fig. 3), and the mean square value of the oscillatory current is measured by means of the thermo-electric couple T-E and the galvanometer G. From the resistance and current, the power corresponding to the oscillations, and dissipated as heat in the circuit is obtained, and is plotted as dotted curves on the same diagram as the static characteristics (Fig. 1), the values



inductance M. When these oscillations occur, the current i_a changes, and the amount of change is determined by applying a small E.M.F. due to a potentiometer arrangement (not shown in Fig. 3) to the terminals p and q, in order to retain unchanged the deflection of the galvanometer. The current in the oscillatory circuit being 8·47 micro-amperes and frequency 58,200~, the cycle of v_c is performed as before, and ∂i_a, the change in current in the anode circuit, is plotted against v_c. The curves obtained for audion No. 1 are given in the lower part of Fig. 3, and those for the other four audions are also given in the original Paper. They are similar in character, and indicate values of ∂i_a depending upon the second derivative of the static characteristic ($d_2 i_a/dv_c^2$), reaching their maximum positive and negative values at points of greatest curvature of the static characteristics. The maximum values of ∂i_a for the five audions are 4·2, 9·1, 8·8, 66·0 and 8·4 micro-amperes respectively. Dividing these by the mean anode current, the numbers give a kind of coefficient of merit for the audions as detectors—15, 48, 35, 165 and 17.

Ageing of the Audion.—On repeating the determination of the static characteristics after an interval of three months, it was found that audions Nos. 1, 2 and 5 had not changed. No. 4 had changed



The Mineral Wealth of Alsace-Lorraine.

The Electrician.
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Reconstruction Problems

Last week the Minister of Reconstruction, Dr. Addison received the Press in conference and discussed various problems of reconstruction which the Ministry now have in hand. We welcome conferences of this kind, for it is only by taking the public into their confidence that the Government will get people to recognise what Reconstruction means and what are the many difficulties to be overcome.

It should be realised at the outset that if steps taken by the Government are to be useful to the maximum extent, the attitude of the Government must be one of assistance rather than of direction. The Ministry of Reconstruction must be, as it were, a clearing house of information between the various trades and industries of the country and the Government. It is for this department to find out what are the essential requirements of every trade; but this is only part of the complete work. If such efforts are to be useful to the full, it is essential that there should be the most complete co-operation between the Government and every trade and industry. Mistakes are certain to occur, but if these are to be reduced to a minimum and useful results are to be a maximum, those responsible for the trades and industries of this country must realise that they will have to work in most hearty co-operation with the Ministry of Reconstruction, and must not imagine that this Ministry is going to do all the work, supply all the initiative and assume the direction of what is required during the period of reconstruction.

It is not permissible here to do more than indicate some of the problems with which the Ministry is faced. In order to deal with these a general Advisory Council has been formed, consisting of four sections. One section of the Council will deal with production and commercial organisation, another with finance, transport and common services, the third with labour and industrial organisation, and the fourth with social developments, including agriculture, education, health and housing. We do not yet know the precise membership of these sections, but we understand that all the principal interests will find a place, so as to make them thoroughly representative. The problems that will arise will be submitted to one or other of these sections, and investigations may also originate with the Council itself. Moreover, the Council and sections will work with the various Government departments so as to avoid anything in the nature of "watertight" compartments, and thus the Council will be able to survey the programme as a whole.

One of the most difficult problems is the returning of [illegible]

essential industry, as far as possible, into war work, and at the same time to supply such industries with the minimum of raw materials with which to keep them alive. Even in the case of essential industries the problem of supplying the necessary raw material is one of considerable difficulty because the claims of one industry must be considered against those of another, and also in accordance with the requirements of war. These difficulties can be appreciated somewhat easily at the present time and under present conditions, but it is not fully realised by the general public that the same difficulties will be present for a considerable time after the declaration of peace. During this time lack of shipping and the transport requirements of the military authorities will introduce serious difficulties, and the claims of the various industries will have to be weighed with care.

Another difficult matter will be the provision of the necessary stocks for opening up normal trade after the war. In many cases pre-war stocks have been used, and have not been replaced, owing to high prices and in the hope that lower prices will rule when the purchase can no longer be delayed. If stocks fall below a certain minimum, it is impossible to carry on satisfactory business.

Those who were opposed to the formation of a Ministry of Reconstruction must surely begin to realise that there is no lack of problems for most careful consideration. Apart from those to which we have already referred, there is, for example, the status of our seamen in the mercantile marine, to whom this country owes a deep debt of gratitude at the present time for their heroism. The conditions under which the seaman earns his living are by no means always what they might be, and as far as we are aware there is no body to which matters concerning the seamen could be referred before the establishment of the National Maritime Board. Probably the sailor has a broader outlook of life than those who are accustomed to remain continuously in this country, and thus he is prepared to accept conditions which other sections of labour would refuse. Then again we have such problems as the employment of juvenile labour, the provision of adequate housing for the labouring classes and the modification of by-laws in regard to buildings.

We were glad to hear from Dr. Addison that the scheme for demobilisation is practically complete. We understand that the first to be released will be those men who are required most urgently, and care will be taken to discriminate between different classes of men. Those which can be considered pivotal—*i.e.*, those men who are necessary in the organisation of a works before serious manufacturing can be carried on—will be released first. Lastly, Dr. Addison laid great stress upon the formation of industrial councils, as suggested in the Whitley report. It was disappointing to hear that progress so far has not been very rapid, though perhaps this was to be expected. New organisations of this kind are not set on foot in a moment. On the other hand, we doubt if the urgency of the problem is recognised in certain quarters. There may perhaps be a feeling on the part of trade unions that they do not wish in any way to tie their hands. It cannot, however, be realised too fully that if the bulk of labour questions are not solved before demobilisation disputes and confusion will arise throughout the country. There is, therefore, an absolute necessity for dealing with labour problems, and not only for dealing with them but for considering them quickly. It cannot be impressed too [illegible] on both employers and employed that they have common interests [illegible] and that there should be absolutely no delay in bringing these industrial councils into being and in solving the many problems that must necessarily arise in the very near future.

Obituary.

SIR JOHN WOLFE BARRY.

As briefly announced in our last issue, Sir John Wolfe Barry, K.C.B., F.R.S., the eminent civil engineer, died on the 22nd ult., at his residence in Chelsea.

Sir John Wolfe Barry was born in London in 1836, being the youngest son of the late Sir Charles Barry, R.A., the well-known architect of the Houses of Parliament. He was educated at Trinity College, Glenalmond, and at King's College, London. After passing through the college he was articled to Mr. (afterwards Sir) John Hawkshaw, and served a regular apprenticeship to his profession, having previously acquired considerable experience of actual building work in the shops of Messrs. Lucas Bros. He was employed by Mr. Hawkshaw as resident engineer on the Charing Cross and Cannon-street railway bridges and stations, and on the completion of the latter work in 1867 he commenced business on his own account. He became a member of the Institution of Civil Engineers in 1868. Among the more important works which he carried out were the Earl's Court station and various extensions of the District Railway, and (jointly with Sir John Hawkshaw) the "Circle Lines" of the Metropolitan and District Railways. He was engineer of the St. Paul's Bridge and station at Blackfriars, for the London, Chatham & Dover Co., the large and important docks at Barry and Newport, in South Wales, Grangemouth, Middlesbrough, Immingham, &c., also the Tower Bridge and the Kew Bridge. On the occasion of the opening of the Tower Bridge he was made a C.B., and at the time of the Queen's Diamond Jubilee he was promoted to K.C.B.

SIR JOHN WOLFE BARRY.

Sir John was concerned with a considerable amount of public work, mostly of a technical kind. He served on the Royal Commissions on Irish Public Works and on the Western Highlands and Islands of Scotland, and on Committees appointed by the Board of Trade for dealing with the estuaries of the Ribble and of the Thames. With Sir Charles Hartley, K.C.M.G., he represented Great Britain for many years on the Suez Canal International Commission for Works; he was a member of the Royal Commissions on Accidents to Railway Servants, of the Royal Commission on the Port of London, and of the Royal Commission on London Traffic. He was chairman of the Executive Committee of the City and Guilds of London Technical Institute, and a member of the Senate of the University of London and of the Governing Body of the Imperial College of Science and Technology. He was Colonel in the Engineer and Railway Staff Corps, and a member of the Army Council and Deputy Lieutenant of the County of London. He was also a member of the Royal Commission on London Traffic. His activity as chairman of the Westminster Hospital disclosed another line of interest.

Sir John was a prominent member of many learned societies. He became President of the Institution of Civil Engineers in 1897, and was re-elected in 1898. He was Chairman of Council of the Society of Arts 1898–99, and was re-elected to that position for 1899–1900. He was a Fellow of the Royal Society and was President of Section "G" (Engineering) of the British Association in 1898, and President of the Association of Technical Institutions for 1903.

In his consulting practice Sir John was frequently concerned with Parliamentary work and arbitrations. He was appointed arbitrator to fix the amount to be paid by the London County Council for the compulsory acquisition of the Sardinia-street station of the Metropolitan Electric Supply Co., in connection with their Holborn-Strand improvement scheme. The proceedings commenced on Jan. 7, 1903, and after several sittings he issued his award in August, 1905, under which the Company were awarded £183,150. He was selected in 1902 by Parliament as one of the three members of the board of arbitration appointed to settle the claims of the Metropolitan Water Companies in the matter of the acquisition of their properties by the Water Board, and the aggregate of the awards amounted to 30½ millions sterling.

Sir John took a keen interest in submarine telegraphy, and was chairman of the Eastern, Eastern and South African, Eastern Extension, and Western Telegraph and of the Globe Telegraph and Trust Companies.

To Sir John was due the credit of bringing the question of Standardisation before the Institution of Civil Engineers. In January, 1901, the Council appointed a Committee to consider the advisability of standardising various kinds of iron and steel sections, and out of this has grown the British Engineering Standards Committee, of which Sir John was Chairman. That great organisation, the foundations of which were so well laid by Sir John, should become of growing utility to the engineering industry, not only of the nation but of the Empire, is so largely because of the principles of equality and justice which, through the commanding ability and foresight of Sir John, were firmly established in its operations.

In Sir John there passes from our midst the acknowledged doyen of civil engineers.

At the meeting of the Institution of Electrical Engineers on Thursday, the 24th ult., the members passed a vote of condolence with the family of the late Sir John Wolfe Barry. Mr. Wordingham said Sir John was one of the pillars of the engineering profession, and one of those who had done most to make that profession attain the honourable position it held.

Electric Starters for Petrol Engines.

Though several mechanical contrivances have been invented for starting petrol engines fitted to motor cars, they have not made anything like the same headway as electric starters. A large number of American cars and a fair number built in this country are now fitted with electric lighting and starting equipments, and it appears that sooner or later all the best cars, at any rate, will be started and lighted by electricity. One essential item for starting purposes is a good storage battery capable of discharging heavy currents for short periods, and the other item is the motor, which must be able to stand these heavy currents; but, since the engine is brought up to speed very rapidly, the motor can, of course, be worked at high current densities. To enable it to develop a large starting torque it must be series wound.

The simplest electric starters are those which have a friction drive, as shown in Fig. 1. Fitted to the end of the motor armature

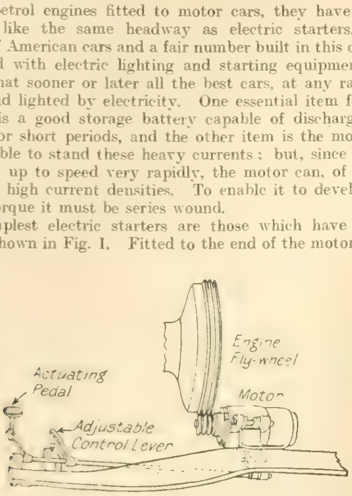

FIG. 1.—ELECTRIC STARTER WITH FRICTION DRIVE.

shaft is a bronze friction roller with three grooves, and when the motor is brought into use the grooves on the pulley fit into those on the flywheel. This is brought about by depressing a pedal which, through the medium of a rod, swings the motor forward upon its hinge until the pulley and flywheel are brought into contact. At the same time a small arm attached to the rod presses upon a switch and starts the motor. In some cases the friction pulley, which is brought into contact with the engine flywheel, is driven by the motor through a shaft with universal joints, and the motor pulley is often a metal or rubber pulley without grooves, and it rubs directly on the flat surface of the flywheel. The battery for working these starters is charged from a dynamo, which also provides current for the electric light.

In many cases a pinion on the armature shaft of the starter meshes with teeth on the periphery of the flywheel. When the switch is closed the pinion automatically shifts into its driving position, and

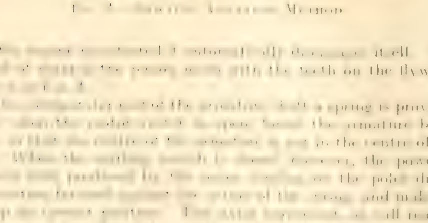

FIG. 2.—[illegible] METHOD.

when the engine is started it automatically disengages itself. One method of making the pinion mesh with the teeth on the flywheel is shown in Fig. 2.

At the [illegible] end of the armature shaft a spring is provided [illegible] the armature back [illegible] the centre of the [illegible]. When the starting switch is closed, however, the powerful magnetic field produced by the [illegible] on the pole draws the armature forward against the [illegible] of the [illegible] and makes it take up the correct position. The [illegible] will readily [illegible] the teeth on the pinion into mesh with those on the toothed flywheel. Owing to the very powerful [illegible] at first [illegible] the teeth as they are [illegible]. As soon as the engine starts the load on the [illegible] is of course reduced and [illegible] the field is [illegible], with the result that the spiral spring pushes the armature backwards and the pinion is moved out of engagement with the teeth on the engine flywheel. The driver has simply to close the starter switch, when the motor is automatically geared up to the flywheel before it begins to turn the engine. To facilitate meshing and de-meshing, the gear teeth are usually chamfered. Another method of making the motor pinion engage and disengage with the teeth on the periphery of the flywheel is to provide the motor with a threaded shaft (*see* Fig. 3). The hole in the centre of the pinion is also threaded, and the pinion is placed on the threaded part of the shaft. As soon as the motor begins to revolve the pinion is shifted by means of the thread into mesh with the teeth on the periphery on the flywheel, the pinion being kept from turning by its inertia; but as soon as the engine begins to fire and its speed rises it over-runs the motor, and the action is reversed. The pinion moves back over the thread until it is out of mesh with the teeth on the flywheel. An unbalanced weight attached to the pinion facilitates the movement of the latter along the shaft when the motor is started, and also prevents the pinion working into mesh with the teeth on the flywheel as a result of vibration. There is a marked tendency, at present, to employ the geared type of starter in preference to the friction drive type, and Messrs. Vandervell and Co. have recently introduced a starter of the former kind.

Sometimes the pinion which drives the flywheel is coupled up to the motor through gearing, thus giving, with the teeth on the flywheel, a double reduction drive. This arrangement enables a small high-speed motor to be used; but this advantage is largely offset by the cost of the additional gear and countershaft. Moreover, American manufacturers who have adopted the double reduction gear arrangement have found that it requires the provision of an over-running clutch to enable the engine to run ahead of the motor when firing occurs, otherwise the armature of the starting motor is apt to attain a dangerous speed before the pinion is disengaged from the teeth on the flywheel. For this reason there is a noticeable tendency to

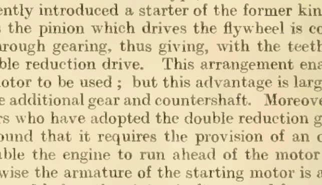

FIG. 3.—THREADED SHAFT METHOD.

adhere to the single reduction arrangement. As a rule, the teeth with which the pinion meshes are cut in the rim of the flywheel; but on the largest engines the teeth are cut around the periphery of a steel rim, which is afterwards mounted on the flywheel. Double reduction gears have been used mainly by American manufacturers when the movement of the pinion into engagement with the teeth on the flywheel is non-automatic. In such cases the pinion is usually thrown into mesh by a fork operated by a lever in the car. As this lever is moved, the motor switch is simultaneously closed; but the motor is not connected directly across the battery until the teeth on the flywheel and those on the pinion are fully in mesh. To secure ready meshing the gears are chamfered. When the lever is released a spring returns it to its normal place, the current is cut off from the motor and the pinion is returned to its original position. A more simple scheme for bringing the gears into mesh by hand is to employ a single reduction and slide the pinion backwards and forward on a square portion of the armature shaft; but in this case the starting motor must not be connected up to the accumulator until the gears are in full mesh.

As any dynamo will work as a motor without the slightest alteration, it follows that a single machine ought to be sufficient for starting and lighting a car. Little progress, however, has been made with the single unit system in this country; but there is reason to believe that it will be more widely adopted in future. In America there have been rapid changes in policy. Cars of the same make have been fitted with one system one year and another the next, and although the combined unit has recently made marked headway, the alternative scheme, involving the use of a separate motor and dynamo, has not by any means been abandoned. Though the design of a combined starting and lighting set does not at first sight appear to present much difficulty, those who have grappled with the problem have found that the production of a cheap, light, compact and efficient unit demands considerable engineering skill, for the working

conditions are somewhat exceptional. When acting as a starting motor, the machine must be capable of taking a heavy current — sufficient in some cases, in fact, to make it develop about 1 H.P. — whilst when acting as a generator it must give a steady voltage and moderate current output over a wide range of speed. To meet these conditions many schemes have been put forward, especially in America and on the Continent; but whilst many are ingenious, and so far as operation is concerned more or less satisfactory, the complications involved have in some cases made the cost exceed that of two independent units. Machines having two commutators and two armature windings, and other unconventional arrangements, are naturally more expensive than those built on more or less normal lines. Moreover, they are more apt to get out of order.

One advantage of the single-unit system is, of course, that the machine can be permanently coupled or geared to the engine. When the engine is started the back pressure of the motor rises with the speed until it reaches a point where it exceeds that of the battery, when the starter becomes a generator and supplies current for the electric light. A machine that has been built for some time past by The General Electric Company of America, and which has been introduced into this country by the B.T.H. Company, is constructed on very simple lines, and would appear to have a good future before it. It differs from an ordinary dynamo only in that it has an auxiliary brush, auxiliary poles, a series field winding and a fine wire opposing winding in addition to the ordinary shunt winding (see Fig. 4). When the switch is closed current flows through the armature and series windings and sufficient torque is developed to start the engine. The starting switch is operated by pushing forward a knob on the dash; but this

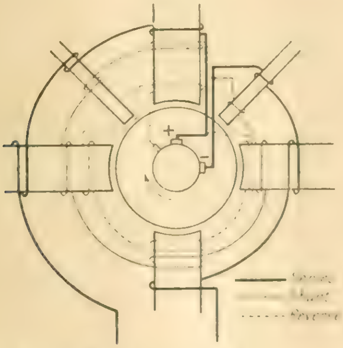

FIG. 4.—[illegible]

[illegible]

Electro-Culture.

The following report has been made by Mr. S. E. Britton, City electrical engineer of Chester, to the Electricity Committee.

The 1·4 acres of pasture adjoining the Overleigh-road Cemetery, used for electro-culture, was ploughed and trenched shortly after Easter and arranged in three plots of, approximately, A 970 sq. yds., B 4,900 sq. yds., C 1,800 sq. yds. The largest plot was equipped for electro-culture and lies between the two smaller plots (Fig. 1).

For comparison three varieties of potatoes were planted, viz.:—Great Scot, Summit and King Edwards, and the following result obtained:

Plot A. Natural Control.	Great Scot.	King Edward.	Summit.
No. of roots	413	315	359
Average yield per root	1·363 lb.	0·485 lb.	1·344 lb.
Plot C. Natural Control.			
No. of roots		238	398
Average yield per root	—	0·567 lb.	1·497 lb.
Plot B. Electro-culture.			
No. of roots	2,294	480	7,294
Average yield per root	1·684 lb.	1·231 lb.	1·451 lb.
	23·5 % increase	153 % increase	7·5 % increase
		117 % increase	3·1 % decrease

With regard to the Summits grown on Plot C, it should be noted that the supply wire from the shed to the discharge wire was passed over this ground, at a height of 8 ft.

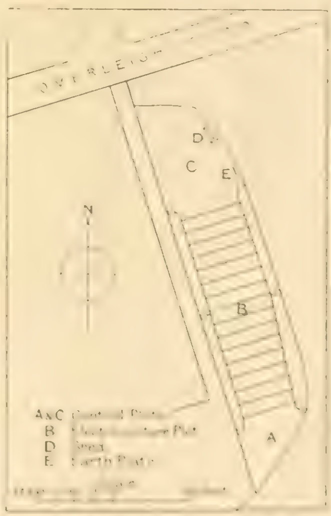

FIG. 1.—PLAN OF [illegible]

[illegible]

This experiment indicates that it is not detrimental to place the discharge wire near to the plant, and that for experimental purposes and to obtain comparative results it is not necessary to have the control plot several hundred yards distant from the plot under electric treatment, as is the case when the discharge wire is placed 10 ft. to 15 ft. above the crops.

The extent to which I have been able to look into this subject leads me to think that although the subject is a complex one, and at the present rate of progress it will take years to develop, the possibilities appear to be tremendous, and, when it is more understood, astounding results may be expected. It should, however, be made perfectly clear

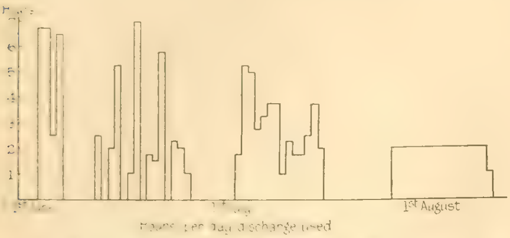

FIG. 2. DIAGRAM SHOWING THE EXTENT TO WHICH THE DISCHARGE WAS USED.

that its present state of development does not warrant its general application, and that there is yet to be evolved a more settled conception of the [illegible] effects and electrical requirements on which to base the practical work; therefore, at the present time, results should be treated as experimental. Probably the most useful progress would be made by encouraging electric supply undertakings in conjunction with plant physiologists to systematically experiment on small plots.

Early experiments demonstrated that the development of electroculture promised to produce results of vital importance, and having regard to what has been achieved in recent years, it is astounding that the Government departments concerned with these matters should be so inactive in utilising the suitable facilities which exist in many parts [illegible] speedy investigation of the problems associated with the use of electricity in producing increased crops.

Fuel and Power Supply.

(COMMUNICATED.)

[illegible] the insistent need for adequate and cheap supplies of [illegible] fuel and power, and the necessity for economy in coal [illegible] one of the most urgent problems which [illegible] at the present time.

In [illegible] industrial development and coming international [illegible] the problem is one that must be tackled energetically, and, at the same time, with due regard for the equally [illegible] of capital expenditure, labour and material.

The [illegible] not to be met by starting [illegible] of power supply, the [illegible] five to seven years ahead [illegible] involves not only huge capital outlay, [illegible] of serviceable plant, but [illegible] extensions to existing power stations.

[illegible] for a rapid economic recovery during the [illegible] period immediately following the cessation of [illegible] existing plant and supply [illegible] supply [illegible] these facilities [illegible], a matter of [illegible] present requirements [illegible] capital outlay, and very considerable [illegible] to the utmost [illegible] plant and coal [illegible] industrial [illegible] electricity supply [illegible]

[illegible] has in the [illegible] healthy [illegible] and power supply, [illegible] been fully recognised, has become completely obscured in stupid antipathy which excludes the possibility of co-operation and joint development on rational lines for the benefit of the consumer.

There is now, however, a growing consensus of opinion among men of eminence in both gas and electrical engineering that there is between these allied industries enormous scope for co-operation and joint working which would be conducive to their mutual advantage as well as beneficial to the consumer. This opinion will, no doubt, be endorsed by men of discernment among the "consumers" whose claim to be heard in matters so closely identified with their industrial and social well-being must be conceded. It is now, in fact, generally realised that stultifying and futile rivalry between industries of an allied character must give way before the stern realities of ruthless and intensified international competition.

A brief review of the present state of development of the gas and electricity supply industries reveals a pressing need for adequate outlet for surplus productive capacity which is common to both; and, to whatever length independent development in either industry is carried, the complete satisfaction of this primary condition of efficiency must remain a factor of prime importance. The inherent general tendency towards over-production of certain combustible secondary products of gas manufacture, on the one hand, and low load factor equally inherent and pernicious on the other hand, would appear to provide an accommodating basis for reciprocal working through the interchange of fuel and power. The direct use of coke in lieu of coal as fuel in the generation of electricity on a large scale has proved the utility of this, the most important of all by-products of gas manufacture; and the adaptability of certain electrothermic and electrochemical processes to "off peak" conditions of working opens up enormous possibilities for improving load factors. These "possibilities" include the working up, by means of electrical processes, secondary products of gas manufacture hitherto sold in the crude state.

Among other advantages, less obvious but no less important, which would accrue as a result of close co-operation on the lines indicated are included the benefits of collective buying of raw material and the avoidance of a double loss in distributing both gas and electricity in scattered areas where either service would suffice. Steam boiler and fuel statistics recently collected by the Controller of Coal Mines will no doubt prove, if such proof were necessary, that to a very large extent the coal used in both industries is identical in kind and characteristics; and so long as miners' wages—which represent two-thirds of the cost of mining coal—are based, not upon output, but upon price, the employment of one instead of two buying organisations would very properly tend to eliminate adverse competition in securing supplies.

At most important gas works, which are in many instances situated contiguous to electric power stations, there are, in addition to water and transport facilities, considerable quantities of waste heat available in utilisable form. Waste gases from retort flues, which might be used for feed-water heating, are often unavoidably discharged at relatively high temperatures; and instead of being wasted in quenching, the sensible heat in the incandescent coke might also be utilised for steam raising, as it is now used, as required, for heating retort settings. The full utilisation of these sources of waste heat would, of course, necessitate the installation of steam boilers and generators in close proximity to retort houses.

Organised capacity for the production of munitions is a factor which should enter largely into any comprehensive scheme of fuel and power supply, and bearing in mind the developed and proved capacity of the gas industry for this purpose, it is to be hoped that in considering the provision of a cheap and adequate supply of electricity due regard will be had to the importance of providing for the pro rata development of gas manufacture and supply.

An Artifical High-tension Line.—In a recent issue of "Elettrotecnica," Prof. L. Lombardi describes an interesting experimental high tension line which has been constructed in the laboratory of the Polytechnic Institute at Naples. Facilities are available for the application of a pressure of 60,000 volts to the line, and it is hoped that it will afford a useful means of testing in the laboratory various practical points involved in high tension transmission. The device deserves attention. It is possible that in the future high tension transmission will play a greater part in the electrical industry in this country, and few if any of our technical colleges are equipped to undertake investigation on this subject.

Correspondence.

THE LATE SIR J. WOLFE BARRY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Due, no doubt, to extra pressure, the obituary notice of the late Sir John Wolfe Barry in last Thursday's daily news-papers was closely limited to a sketch of his [illegible] professional career.

I ask, however, to be allowed to pay a humble tribute to his remarkable personal characteristics. Sir John always struck me as a peculiarly good example of the [illegible] English-man. His charm of manner and speech were in themselves a considerable source of attraction. There were two matters more especially which it was my privilege to periodically dis-[illegible] we took a somewhat different view—perhaps unavoidably: [illegible] condition, due largely to his ready forbearance with the outlook of others (even his inferiors) and his natural breadth of mind.

Sir John Wolfe Barry [illegible]. He was one whom we are never likely to forget, partly on account of [illegible] endearing character [illegible].

London, Jan. 29. [illegible]

Three-Phase Live Roll Motors.

The standard motor designed for ordinary [illegible] driving purposes is totally unsuitable for operating live roll gear and other auxiliary machinery in steel works. The duties imposed upon the motor are so severe that it must have exceptional mechanical strength to withstand the frequent shocks experienced in consequence of the heavy loads suddenly thrown on the motor, the continual rapid reversing, and through the vibration of the gearing. Such a motor must, moreover, be totally enclosed to exclude metallic and other dust which abounds in steel works, and must at the same time have but small rotational inertia so that it will accelerate, retard and

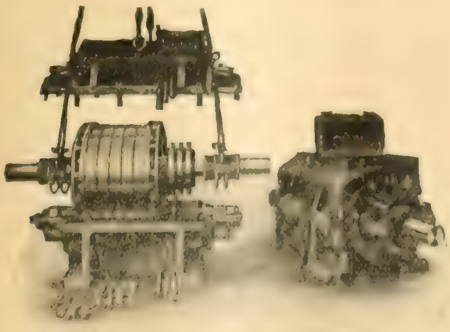

FIG. 1.—[illegible]

reverse rapidly [illegible] [illegible]

current and to some extent [illegible] of the advent of the mixed pressure three-phase turbo-generator which can utilise from exhaust steam a large amount of energy which would otherwise be wasted. A special form of induction motor is [illegible] outlined, and the General Electric Co. have undertaken the manu-facture of machines of this form, which are seen in the illustration and which, [illegible] motors to be manufactured in this country.

In the [illegible] upper portion can be lifted clear, carrying with it the brushgear and the [illegible] secured to the bearing bushes, in which the rotor shaft runs, the bearing bushes being bolted together inside the shell. By attaching the crane slings to these two eyebolts, the bushes can be lifted out carrying with [illegible]

In order to permit rapid acceleration, retardation and reversing, the [illegible] a large holding down bolt. Where the conductors enter the machine, they are carried by strong insulating cleats protecting the leads from abrasion against the carcase. The motor is symmetrically constructed, [illegible] be taken from either end of the machine when first installed but, if by [illegible] motor can be completely turned round on its foundation bolts and can then be driven from the other end, the centres being exactly the same. The extension end can also be used if necessary for a solenoid brake. This class of machine is being satisfactorily used in steel works, not only for driving live rolls but also for cranes and other auxiliary machinery. [illegible]

Legal Intelligence.

Tungsten Filaments Patent Litigation.

On the 24th [illegible] House of Lords [illegible] [illegible] lants' filaments were [illegible] mere built up body of [illegible]

which could be worked hot. Such a body was entirely novel at the date of the specification. It was not melted tungsten, but was an aggregate of tungsten particles in coherent form. On various grounds respondents alleged the patent invalid, but the main ground was want of novelty and subject-matter. Mr. Justice Astbury had no evidence upon which he could hold as he did in favour of respondents' defence. No one had succeeded in obtaining a workable body of molten tungsten. He was wrong in thinking that the specification disclosed not subject-matter [illegible] the working of fused tungsten while hot; and that the working of the fused metal hot was merely the utilisation of the common tools and routine of the metal worker and was not the subject of invention. Counsel then dealt with the evidence.

The case had not concluded when we went to press.

Liability for Defective Street Lighting.

At [illegible] London County Court last week Mr. F. D. Baldock, [illegible] driver, brought an action against the City of Westminster Council, the Charing Cross, West End & City Electric Supply Co., to recover damages for injuries to his taxicab in a collision with an unlighted refuge in Cockspur-street.

Mr. Brandon (for plaintiff) said that the action was first brought against the Council, but as they had a contract for street lighting with the company, the latter had been joined as co-defendants. There was no light on the refuge on the night of the accident (March 20, 1917). The Council admitted that they were responsible for the maintenance and standard of refuge, but they were not liable for the lighting of the streets. It was contended that it was their duty to put up a red storm lamp if the ordinary light was out. The company pleaded the Defence of the Realm Act and the regulations made thereunder as to the street lighting.

Evidence of the facts having been given by the driver of the taxicab, his Honour dismissed the company from the action without costs, and the [illegible] against the Council.

Mr. L. J. BEIT, assistant surveyor and supervisor of street lighting to Westminster City Council, gave evidence as to the regulations made by the War Office and Home Secretary with regard to street lighting. The usual procedure was that when a light went out the police called the attention of the company to it. Some of their men were out all night, and if a light was out they reported it, and if they had one they might put up a red lamp. The actual number of lamps that went out was not [illegible], probably about 20 or 30 a year. It was not the general practice to put red lamps on refuges in London. Evidence was given that the standard and the street refuge in question were whitened, and a police constable stated that the lamp was alight at 8.15 p.m., or five minutes before the accident occurred.

Mr. W. B. THORPE, distributing engineer to the Charing Cross Company, gave evidence as to the steps taken to reduce the light given by the lamps in Cockspur-street. They had to keep the carbons at a V-shaped position, and in normal times the actual pressure kept them in place, but they had to reduce the pressure to 100 volts, and as that did not keep them in place the results were very unsatisfactory. The lamps were not designed for the lower pressure. They could not have avoided or foreseen the lamp going out. Certain questions were left to the jury, and they found that the accident was not due to an inevitable accident caused by the diminution of the street lighting; that it was due to the [illegible] of the Council owing to their omission to maintain a light on the refuge; that the accident was not contributed to by plaintiff, and that the lamp on the refuge was not alight at the time of the accident.

Judgment [illegible] pending argument on a point of law raised [illegible].

Volunteer Notices.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

Headquarters: Balderton [illegible], Oxford-street, W. 1.

Officer Commanding: Lieut.-Colonel C. B. Clay, V.D.

Orders for the Week.

[illegible]

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Wherever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1916 SPECIFICATIONS.

[illegible] WHITE, A. E. United States Light & Heat Corpn. Storage battery plates. (22,9/16.) 112,134.
13,943 CORK, F. L. Telegraph or telephone sets, particularly portable or field sets. (30/9/16.) 112,136.
[illegible]44 [illegible], E. C. R. Société Anonyme des Etablissements L. Blériot. Magnetos with fixed armatures. (18/12/16.) 112,038.
15,802 HOEDT, C. N. de. Telegraph keys. (4/11/16.) 112,139.
16,567 HARRISON, H. H. & CREED & CO. Apparatus for producing perforated strip by electrical current impulses. (18/11/16.) 112,141.

1917 SPECIFICATIONS.

436 CODD, M. A. Induction coils or transformers. (9/1/17.) 112,051.
584 HUBBARD, W. S. Control gear for electrically driven cranes. (11/1/17.) 112,174.
713 KING, C. F. L. Electric lamps for motor vehicles and for other purposes. (15/1/17.) 112,055.
1,146 FILMER, G. B. & DENTON, J. J. Electric furnaces. (23/1/17.) 112,177.
2,340 VIERSON, J. H. VAN, AND SLOT & ZWIJNENBERG. Process for joining up electric and other wires. (2/9/16.) 109,432.
2,674 FOREMAN, J. S. & DRAKE & GORHAM. Fittings or supporting combinations for electric lighting and other purposes. (23/2/17.) 112,195.
3,347 SINGER, O. G. Spark plug intensifiers. (7/3/17.) 112,201.
4,144 PLETSCHER, O. Magneto-electric machines. (21/3/17.) 112,206.
4,335 B.T.-H. CO. & SUGDEN, J. Starting switches for electric motors. (26/3/17.) 112,209.
7,606 WESTERN ELECTRIC CO. Cores for Pupin loading coils, magnets, and the like. (26/5/16.) 107,007.
8,598 ROBINSON, W. J. X-ray tubes. (15/6/17.) 112,101.
An X-ray tube having two metallic electrodes both on the outside of the vacuum chamber, in contact with its walls, one being at the end of the tube and the other at an intermediate point of its body.
8,726 [illegible], A. S. Device applicable to [illegible] switches of telephone receivers. (18/6/17.) 112,102.
9,317 HARSCH, C. A. Fire-detecting wires for electric circuits. (28/6/17.) 112,239.
10,019 MCLEAN, N. Electric portable hand lamps and the like. (2/2/17.) (Divided application on 1,678/17.) 112,240.
14,896 PEASE, W. H. Sparking plugs. (15/10/17.) 112,256.
14,981 KESELLRING, F. Continuous-current dynamos. (8/6/16.) (Divided application on 8,150/16.) 112,116.

APPLICATIONS FOR PATENTS.

NOTE. *The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

January 4, 1918.

248 PEARCE. Electric protective apparatus for alternating currents.
251 ALLINANNA SVENSKA AKTIEBOLAGET & SELIGMAN. Free-release circuit-breakers.
252 ALLINANNA SVENSKA AKTIEBOLAGET & PETERSEN. Electric syrens.

January 5, 1918.

283 GOLDSTONE. Attachable hook-holder for electric torch lamps, &c.
290 COWPER-COLES. Separating electro deposited metals from their matrix.
306 NEWTON & WRIGHT. Automatic time switches for controlling X-ray exposures, &c.

January 7, 1918.

336 MARSH. Ignition magnetos.
354 MCKENZIE, HOLLAND & WESTINGHOUSE POWER SIGNAL CO. Railway signalling.
363 RYMER-JONES. Apparatus for measuring want of equilibrium in galvanometer coil, &c.
379 WILLSON. Telegraphic apparatus.
386 LJUNGSTROM. Electrically propelled vehicles.

January 8, 1918.

[illegible] & SERIVENER. Attachable mouthpieces of telephones, &c.
411 WESTERN ELECTRIC CO. Electron emitting-cathodes.
420 QUASI ARC CO. & STROLMENGERS. Electrodes for electric welding.
[illegible]
423 BOWMAN & SMITH. Electric guns. (29/5/17. U.S.)
431 ORAM. Overhead system of electric traction.
[illegible]
442 B.-T.-H. CO. (G.E. CO.) Couplings.
474 LELY & N.Y. PHILIPS' GLUHLAMPENFABRICK. Incandescent lamps for projectors. (2/6/17. Holland.)
[illegible] (8/1/16. Italy.)
[illegible]

January 9, 1918.

[illegible]
for drum armatures of electric commutator machines.
[illegible]
carbon electrodes.
[illegible]
557 BROWN. Silencing pad for telephone ear-pieces, &c.
[illegible]

January 10, 1918.

[illegible]
587 CORNELL. Magnetic separators. (12/1/17. Australia.)
[illegible]

January 11, 1918.

[illegible]

Commercial Topics.

Coal Output.

The annual report of the Chief Inspector of Mines states that during 1916 the total value of the minerals raised in the United Kingdom amounted to £214,933,524, an increase of £43,576,266 compared with 1915.

The total output of coal was 256,375,366 tons, a decrease of 5,169,285 tons. The average price of coal was 15s. 7·24d. per ton, compared with 12s. 5·60d. in 1915. The quantity of coal exported, exclusive of coke and manufactured fuel and of coal shipped for the use of steamers on foreign trade, was 38,351,553 tons. The total quantity of coal which left the country was 55,001,113 tons, against 59,951,925 tons in 1915. The amount of coal remaining for home consumption was 201,374,253 tons, or 4·525 tons per head of the population. 21,589,[illegible] tons of [illegible] were obtained. The output of iron ore was 13,494,658 tons.

The coal output in Scotland was 36,004,631 tons, coke output, 1,378,238 tons, iron ore [illegible] about 30 per cent. of metal, 365,175 tons; [illegible], 1,124,862 tons, and lead ore, 3,910 tons.

Industrial Councils.

A conference of representatives of [illegible] in the metal, engineering and allied trades of the Birmingham district was held in the Council Room of the University on Monday for the purpose of considering the Whitley report.

Representatives attended from [illegible] trade unions and associations of employers. Sir William Ashley, dean of the faculty of commerce, who convened the conference, presided over the gathering, and among those present was a representative of the Ministry of Labour. The general discussion was in favour of the objects of the report, though some criticism of the methods proposed was made. Some speakers emphasised the unity of interests among all the trades of the Birmingham district, and urged that this was not sufficiently recognised in the report.

At a conference of tramway workers and tramway companies which was held on Tuesday, under the chairmanship of Sir Geo. Askwith, it was agreed to take measures to set up [illegible] councils on the lines of the Whitley report. The workers desired [illegible] and disputes about wages to be dealt with nationally; but this was opposed by the employers, who hold to the present system of dealing with such disputes by arbitration.

*   *   *   *

Latin American Trade.

Sir Robert Kennedy, Envoy Plenipotentiary to Uruguay, has recently returned, and, in the course of an interview (reported in the "British and Latin American Trade Gazette") he pointed out that before the war there were about £50,000,000 of British capital invested in the small and friendly Republic of Uruguay, £125,000 in Brazil, and over £300,000 in Argentina.

Sir Robert Kennedy said that fact should convince timorous exporters who were fearful of risking their goods against possibly bad debts in Latin [illegible] entitled us as a nation to consideration. Altogether, both on sentimental and on more solid grounds, we had very much in our favour to encourage our manufacrurers to attain and keep the leading position in the Latin America markets. In the past unwillingness to look forward seemed to have become a national characteristic almost. Owing to the war our foreign exports had diminished. Meanwhile Japan, untrammelled by war necessities, and the United States until recently, were able to continue manufacturing and to send their output into the markets which hitherto had been British. [illegible] The world would be everybody's market after the war. As regards the individuals of this or other nations [illegible] preparation for doing business in Latin America [illegible] in other markets abroad would not, in the ordinary [illegible] on even terms with the man—or nation—prepared, or already established, in business relations with these foreign [illegible]. [illegible] Latin America made it a market [illegible] in the world. The way to secure the trade was already [illegible] well utilised by British exporting firms which had opened and maintained branches in the great and wealthy cities of the Republics. [illegible]

The Paper Restrictions.

A deputation will shortly wait upon the President of the Board of Trade in order to present a petition for the withdrawal of the Paper Restrictions (Consolidation) Order, 1917. No doubt the commercial community [illegible]

An Electrical Engineering Combination.

There are persistent, and we believe well-founded, rumours of an impending amalgamation of forces by Messrs. Vickers, Ltd., and the British Westinghouse Co.

[illegible] the "Financial News" announces that Sir Ernest Hiley has recently joined the board of the [illegible] company, [illegible] (Electric Holdings, Ltd.), of which Mr. F. Dudley Docker and Sir E. Hiley are directors, was formed to acquire a controlling interest in the British Westinghouse Co. The majority of the shares of Electric Holdings (Ltd.) are held by the Metropolitan Carriage, Wagon & Finance Co. [illegible] Messrs. Siemens Bros. & Co., Ltd., whose shares are now held by British subjects, is practically merged already with one undertaking of the above group.

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U.S.A. and Petrol Economy.

Cable advices from New York show that President Wilson is taking a personal interest in steps to bring about petrol economy without undue disturbance of transport interest.

He has agreed that every encouragement shall be given to the continued output of electric lorries both for home trade and export to the United Kingdom. The U.S.A. aeronautical department has purchased the rotary engine division of the Long Island City factory of the General Vehicle Co. for £500,000, but the terms of the Government contract expressly protect the electric vehicle departments, and every facility will be provided for their increased production, if required. It is understood that the present depletion of transport in the United Kingdom largely accounted for the decision not to interfere with the General Vehicle Co.'s export trade.

*   *   *   *

Capital and Labour.

At Greenock last week, Mr. W. L. Hichens (chairman of Messrs. Cammell, Laird & Co.) delivered an interesting lecture on "Some Problems of Modern Industry."

Mr. Hichens stated that the solution of the industrial problem lay beyond mere intellect and legal formulæ, beyond all economic laws and doctrines, and depended on our attitude towards social existence—in plain terms on our moral code. If we were to solve the problem it could only be by recognising that industry was primarily a national service, and that the object of those engaged in it was first and foremost the good of the community as a whole. The lecturer stated (1) That no business was entitled to make unlimited profits. Labour, the entrepreneur class, capital, and the consumer were all partners in the business of the community, and no one class was entitled to benefit unduly at the expense of another. The principle of the profits tax should therefore be retained after the war. Effect must somehow be given to the principle that no section of society was entitled to an unlimited share of the wealth of the community, that free competition had proved an impossible solution, and that profit-sharing with the State—which was what, in the effect, an excess profits tax was—was more equitable and more expedient than other forms of profit-sharing. It followed (2) that the reward of labour must in the last resort be determined by the State as representing the community. Labour had no more right than capital to make a corner in its own commodity and hold the community up to ransom. The tendency would develop for wages to be settled by joint industrial boards representing employers' and workers' organisations, but in the event of disagreement or collusion to exploit the community the State must have the right of intervention. The principle of national service required (3) that the status of [illegible] should be raised. The workers were clearly entitled to have an effective voice in regard to the general conditions under which their work was carried on. It was a grave defect in organisation that so many Government Departments meddled in labour matters. There should be one Government Department only (the Labour Department), not half a dozen, and that salutary reform would [illegible]. [illegible] special time rates should be fixed by the joint district councils. Each [illegible] who were responsible for [illegible] The question (4) of the reduction of the hours of labour was one of the most important problems awaiting solution. [illegible] of all for industry was [illegible]

[illegible] supply our economic supremacy would be jeopardised. One further instance of wasted effort was that involved in unrestricted competition. What is wanted is big selling combinations and a variety of manufacturing units. The principle might be applied at once with great advantage to many of the standardised trades, and encouraged where it already existed. Otherwise it would be impossible for British industry to hold its own abroad against the big trusts and cartels of other nations, and, which was even more important, it would be impossible to take effective action to prevent over-production.

* * * *

A British Empire Trade Mark.

[illegible] the efforts of the British Empire League to [illegible] proposal refused by the Board of Trade in 1914, to create a British Empire trade mark, a number of important manufacturing [illegible] have stated their objections to the scheme.

It is pointed out that recent circulars of the British Empire League suggest that France and other Allies had established marks of origin for their goods, but opponents of the proposal deny that the French Govern- [illegible] against the proposal are that it would be easy and safe for foreign manufacturers to imitate such mark; that in most countries there is no legislation which would pro- [illegible] and seriously [illegible] of the most important British manufacturers have stated they will not use an Empire trade mark, it would be used principally by the less-known manufacturers in England and the Colonies, and, not being a test of quality, would acquire a reputation of indicating inferior goods, and would thus cause [illegible] manufacturing community. The cost of working the association would be enormous, whereas the whole object of the promoters of an Empire mark can be obtained by manufacturers marking their goods "Made in England" or "Made in Canada," as the case may be.

* * * *

Manganese Ore in U.S.A.

The United States Geological Survey is collecting statistics of the [illegible] for each quarter.

The shipments of ore over the first six months of 1917 were greater [illegible] of 1916. In 1916 only 26,996 tons of manganese ore was shipped by 55 operators, but in the first nine months of 1917 70,225 tons was shipped by 88 operators. The reports indicate that the shipments for the year will be about 122,275 tons.

Electricity Supply.

Extensions.

Blackpool. The Electricity Committee will lay a main to give an additional supply of electricity for light and power at the King's Lancashire Military Convalescent Hospital, provided the military authorities pay one third of the cost.

Glasgow. The Electricity Committee has decided to purchase a second 15,000 kw. turbo-alternator for the new generating station at Dalmarnock at £110,000.

The engineer and manager (Mr. W. W. Lackie) reported that the in- [illegible] November last would entail on the electricity department a further additional expenditure during the current year of about £16,000 [illegible] further increase in the charges [illegible]. The Committee, therefore, [illegible] until May 31 [illegible] increased by 0.10d. on [illegible] increased by 15 per cent.

Newport, Mon. On Monday the Town Council in committee [illegible] Committee in [illegible] at the East Power Station [illegible] the borough electrical engineer (Mr. J. Nichols Moore) [illegible] the L.G. Board [illegible] Ministry of Munitions [illegible]

[illegible]

set of not less than 3,000 kw. Apart from the desirability of providing for next winter's load, it was necessary that having regard to the increasing size of the undertaking there should now be sufficient three-phase plant available to provide an equivalent standby to the 3,000 kw. set. It was desirable within the next 12 months to re-blade a considerable portion of the turbine rotor, and this meant the removal of the rotor from the works for a considerable period. He was satisfied that material improvement in steam economy could be effected by the re-arrangement of the auxiliary plant by the introduction of an electrical drive to supplement the existing steam drive. The auxiliary steam turbine was necessary and economical at full load or overloads, but at lower loads motor driven auxiliaries would be more economical. In neither case was it necessary to make an extension to the engine house. It was possible by removing No. 1 d.c. switchboard and transferring it to an annexe outside the engine house, to install in the place left vacant a maximum of 8,000 kw. The cost of providing the new annexe and transferring the switchboard was £3,303. The alternative to that was to supersede No. 3 reciprocating set and erect the new plant in its place, the estimated cost of this being £2,294, after allowing £1,000 as the residual value of the plant. The reconstruction of the d.c. switchboard was overdue, and therefore its removal and reconstruction would achieve a double object. With the additional cooling tower and induced draught plant now in course of erection they could cope with next winter's demand without additional boilers, provided the 3,000 kw. set was available; but he suggested that it was highly desirable to proceed with that portion of the scheme covering the alterations to the boiler-house building, so that when the time arrived as little delay as possible would occur in installing the new boilers. He also advised the purchase of an additional feed pump, which was recommended in the last report, and the provision of additional e.h.t. and l.t. switchgear.

Mr. Nichols Moore stated that he had considered the possibility of avoiding any extension to generating plant or boilers by linking up with the power station of the South Wales Power Co. at Treforest. It was possible to effect a linking up with the company and take a supply, provided the Council approved such a policy and were willing to incur the cost. One of the chief obstacles was the difference in frequency, and that meant the introduction of frequency changers for inter-connection purposes. Assuming the power company could give a supply of 1,500 kw., to obtain this small amount would, on a basis of a 22,000/30,000 volt transmission line, necessitate an approximate expenditure of £30,000. Apart from the high capital cost per kilowatt, there were many serious objections to such a proposal. Frequency changers were in a measure a type of plant to be avoided if possible, and he did not think that in this country sets of even very moderate capacity were in commercial use, and their operation was complicated. There was also the question of the conversion and transmission line to be taken into account, and a much more important question of policy as to whether it was desirable or not that the power company should serve them. He had not overlooked as a possible alternative means of linking up the introduction of rotary converters instead of frequency changers, but with that arrangement only d.c. current could be taken, and with the present arrangement of distribution and demand the amount which could be taken would be limited to 1,000 kw., and such an arrangement would, for practical purposes, preclude the possibility of a reciprocating supply, and it could not furnish any direct stand-by to their existing three-phase generating plant.

With reference to national electricity supply, Mr. Nichols Moore recommended the Electricity Committee as follows: (1) To install an additional turbo-alternator designed for a 6,000-volt three-phase supply at 50 ~, and not less than 3,000 kw. capacity, preferably 3,000 kw.; (2) to proceed with alterations to boiler-house buildings, and to provide accommodation for a subsequent installation of two boiler units; (3) to provide one 250 k.v.a. transformer for works auxiliaries; (4) to provide an electrical drive for the existing 3,000 kw. set; and (5) to provide an additional feed pump of not less than 6,000 gallons per hour. The total cost of the 3,000 kw. set was £30,525, the annual charges (including interest and sinking fund) £3,232, and the revenue charges £593. Detailed estimates of the cost of a 1,500 kw. set and the boiler-house extensions, &c., were also given.

In a supplementary report Mr. Nichols Moore sets out additional reasons for the above recommendations, and after full consideration the Electricity Committee adopted same.

General.

Aylesbury. The Council has agreed to give a supply of electric current to Messrs. Hunt, Barnard & Co. for power and lighting.

Belfast. In regard to the lighting of the new fitting-out wharf, the Harbour Board have approved the engineer's proposal to erect 11 electric light masts and lamps in certain positions.

Carrick-on-Shannon. Owing to inability to obtain a supply of anthracite coal, there has been a breakdown of the electric supply, and shopkeepers have had to resort to candles on more than one occasion recently.

Greenock. The salary of the chief assistant electrical engineer Mr. W. E. Smith has been increased by £75 per annum.

Hamilton Slander Case. At the local Sheriff Court last week Mr. C. T. Moller, manager of the Lanarkshire Tramways Co., sued Mr. Wm. Barton for slander.

Pursuer alleged that while travelling in a car (accompanied by his wife and [illegible]) defender made the slanderous statement that he (pursuer)

was of German birth, a statement which had caused him much annoyance and might have had disagreeable consequences.

Defender, through his solicitor, now submitted an apology to pursuer and withdrew the statement absolutely, besides offering to hand over a donation to the Red Cross.

Pursuer accepted the apology and the accompanying offer, and Sheriff Shennan said defender had acted wisely in thus making amends for what he knew to be untrue.

Ilford.—The Staff Administration Committee recommends that the salary of the electrical engineer and manager (Mr. Arthur H. Shaw) be increased from £500 to £600, by [illegible] increments of £50, the first increment to date as from Dec. 1 last.

Llandudno.—The Council has given 12 months' notice to the local electric tramway company of intention to cease supplying the company with electric energy.

[illegible]

Electric Traction.

Halifax.—[illegible]

Linking Lancashire & Yorkshire Tramways.—Hebden Bridge Urban Council [illegible] Todmorden Council [illegible] Yorkshire and Lancashire [illegible] ways at Hebden Bridge [illegible]

[illegible] matter, Halifax Corporation to extend, but on condition that all cost of road widenings should be borne [illegible] that net profits or losses on the running of the new section should be shared equally between Halifax and Hebden Bridge, and that the latter should extend for 21 years the lease for the Halifax tramways in their area.

Metropolitan Association of Electric Tramways Managers.—A meeting of the members of this Association was held at the Municipal and County Club, Whitehall-court, S.W., on the 18th inst., when there were present:

Messrs. [illegible] Hammond (Met. Elec.), Mason (South Met.) and Mackinnon (London United). Letters of regret at inability to be present were received from Messrs. Harvey (Ilford), Murray (Walthamstow), Stokes (Bexley Heath), Williams (Erith) and [illegible]. Various matters of interest were discussed.

Tramway Travelling Kitchens.—Ald. C. F. Spencer, chairman of the Halifax Tramways Committee, who was recently appointed Director of the Central Kitchen Division of the Ministry of Food, has taken up his duties.

It is understood that the [illegible] travelling kitchens to run on existing tramway lines [illegible] templated scheme. Lord Rhondda has also asked for the transfer of the services of Mr. [illegible] so that he may act as [illegible] to Ald. Spencer.

Tramway Workers' Wages.—[illegible]

West Ham.—[illegible]

[illegible]

Telegraphy and Telephony.

Australian Wireless Station's Record.—[illegible]

Radio-Telegraphy in South America.—[illegible]

The Telephone in Egypt.—It is announced that the negotiations for the purchase by the Egyptian Government of the telephone system belonging to the Telephone Co. of Egypt have reached an advanced stage, and the project will be submitted to the next Council of Ministers.

Imperial Notes.

Australasia.—The "Australian Mining Standard" says the committee appointed nearly two years ago by the Government of New South Wales to investigate Mr. [illegible] stimulation, consisting of Prof. David (chairman), Profs. Cooke, Madsen, Vonwiller and Fawsitt, Mr. O. W. Brain (chief electrical engineer of N.S.W. Railways) and Mr. W. Corin (chief electrical engineer of Public Works, N.S.W.), had the following entry inserted in the minutes of a recent meeting:—

In closing the investigation, the committee places on record the fact [illegible] of members which justifies the claim that any advance has been made in Australia in the direction of causing or increasing rainfall.

Details of the King River (Tasmania) hydro-electric scheme are being prepared by the State department for submission to Parliament during the present session. It is probable that the transmission line from the main station, near the Harris Reward Mine, will be taken to the Mount Read-Rosebery treatment works via the Lake Margaret power station, between which and the Rosebery and Zeehan districts lines have been surveyed by the Mount Lyell Co.

Work in connection with the extension of the Lake Margaret hydro-electric power scheme, designed to supply an additional 2,500 H.P., bringing the capacity of the plant up to 7,500 H.P., is being pushed ahead.

[illegible] company's scheme, shows that it will include the utilisation of the whole water resources of the Bogong High Plains. The Kiewa River, which descends from these plains, maintains its flow better during droughts than any of the other rivers of Northern Victoria, and it discharges a larger volume of water relatively to its catchment area than any other of those rivers. The surveys and records show that the head waters of the Kiewa form the outlet for the greater part of a district which, being situated at an elevation of from 5,550 ft. to 6,000 ft., has a climate similar to that of Norway, and a rainfall comparable to that of the West Coast of Tasmania. The company proposes to create lakes in two of the valleys of the table land, which would store 30,000 cubic ft. of water annually from the rain and snowfall of the winter and spring, and to discharge this water in the summer season back into the Kiewa River, through water turbines having a total fall of 3,750 ft. They would thus be enabled to generate approximately 30,000 kw. of electrical energy continuously, as well as to increase the summer flow of the river.

A recent report of the Commonwealth Advisory Council of Science and Industry contains the resolutions adopted by the Council at its meeting held in Melbourne in July. The Council urged the Federal Government to proceed immediately with the establishment of a permanent Institute of Science and Industry, as the financial and executive powers of the present temporary organisation are inadequate. It pointed out that the various State Governments are anxious to undertake investigations with a view to developing industries of importance to their respective States. In some instances they are already taking steps, in others they are holding their hands pending the organisation of the Commonwealth enterprise. Unless action is taken speedily to establish a Permanent research Institute, the Council fears that the present favourable opportunity of obtaining the co-operative assistance of the State Governments will be lost. The Council recommends that some machinery whereby the State Governments [illegible] with the Institute should be set up. It is recommended that the Institute [illegible] business and financial man, with ability in organisation, whilst the other [illegible]

Foreign Notes.

Spain.—The report of the Spanish Chamber of Commerce at Bilbao for 1916 gives particulars of the shipbuilding, mining and metallurgical industries of the district.

The report states that during the year 97 new companies were formed, representing a total capital of 35,055,968 pesetas (£1,402,240). In 1915 the number of new enterprises formed was 56, with a capital of 7,860,950 pesetas (£314,440). Of the 97 companies formed in 1916, 31 were mineral and metallurgical enterprises, with a total capital of 19,011,706 pesetas.

A Spanish Royal Order, dated Oct. 8, ordains that a Commission of the Directorate-General of Industry and Commerce shall within four months, draw up and present to the Government a Memorandum dealing with questions relating to the foreign trade of Spain.

The Order states that the country will be strengthened economically by the widening of its horizon beyond the needs of the day, and by anticipating the needs of the future. The Commission will deal with (1) The state of the foreign trade of Spain in 1913 and 1914—the competition encountered; and the reason why Spanish manufacturers found it impossible to retain markets. (2) The disturbance of or modifications in the world market occasioned by the war—including particulars of markets lost and won by Spain; Spanish industries that have increased their productive capacity by entering such markets; and enquiry as to the permanent or transitory character of new exports from Spain, [illegible] strengthening of former branches of the export trade. (3) Analysis of the economic consequences of the war—including the possibility of economic wars being instituted, and of the formation of two great irreconcilable groups, or the necessity in which these latter may find themselves of living together economically with no greater separation than that of certain differential tariffs among allies, or the forced submission of both parties to the economic laws of reciprocity and exchange; an enquiry into the system of commercial treaties, &c.

Uruguay.—The Government has assented to the petition of the management of the State Electrical Works that 5,000 tons of the 7,000 tons of fuel oil held in Montevideo by the West India Oil Co. shall be assigned to the State electrical works, and also that these works shall have preference in the case of future shipments of this fuel.

In spite of this decision, anxiety is still felt by the authorities as to future fuel supplies. It is said that one of the measures under consideration to overcome this difficulty is to authorise an arrangement with the United States Government whereby that of Uruguay would cede part of the [illegible] space of the requisitioned German steamers in exchange for 12,000 [illegible] fuel oil monthly.

Miscellaneous.

Disclosure of Official Secrets.—At Bow-street (London) Police Court on Saturday last, Mr. Alfred H. Gibbings was summoned for having on Nov. 2, 1917, in contravention of the Official Secrets Act, attempted to communicate to a correspondent in Switzerland certain information which he had obtained by virtue of his position as a person holding office under his Majesty.

[illegible] prosecuted, and defendant was an engineer in the [illegible] department of the Ministry of Munitions. He entered the [illegible] 1916, and in 1917 he was sent to Switzerland to [illegible] tools. In consequence of defendant's report Mr. Ashworth, one of the chief technical officers of the Ministry, went to Switzerland to make purchases and to report. After his return Mr. A[illegible] a copy of the report, and on Nov. 2 defendant [illegible] in Switzerland, and suggested the formation of a syndicate of Swiss manufacturers to trade in machine tools in this country, Mr. Gibbings being the accredited agent. In the letter to [illegible] Mr. Ashworth's report, but the letter was [illegible] the Postal Censor [illegible].

[illegible] defendant was committed for trial, and on [illegible] the Central Criminal Court to four months' [illegible].

Association of Teachers in Technical Institutions.—A meeting of the Association will be held at the Polytechnic, Regent-street, W., [illegible] at 3 p.m., when resolutions will be submitted [illegible] with the following points:

[illegible]

British Westinghouse Employees' War Relief Fund.—The account [illegible] the period from Aug. 2[illegible] 1914 to Dec. 31, 191[illegible] [illegible]

[illegible]

Employment in Iron and Steel Trades.—The Minister of Labour has appointed an Iron and Steel and Kindred Trades Central Advisory Committee consisting of 10 members (employers) to advise and assist the Ministry on questions arising out of the administration of employment exchanges. Mr. J. J. Burton, J.P., of the Cleveland Iron Masters' Association, is chairman of the committee.

Non-Ferrous Metal Bill.—The report stage of this Bill was concluded in the House of Commons on the 23rd ult. The Bill was read a third time.

Presentations.—On Saturday last Sir James M'Kechnie, K.B.E., general director of Messrs Vickers (Ltd.), was presented with mementoes of the honour recently conferred upon him by the King.

The presentations took the forms of (1) an illuminated address in book form, containing photos of the principal members of the staff and the signatures of nearly 7,000 of the 8,000 persons employed at the Company's Lancaster works; and (2) a smoker's cabinet presented by the staff.

Mr. John F. Loam, assistant superintendent at Penzance of the Western Union Telegraph Co., has retired after over 36 years' service, and he has been presented with a handsome silver tea tray by his colleagues. Mr. T. O'Donoghue succeeds Mr. Loam.

The $12\frac{1}{2}$ per Cent. Bonus.—It is officially announced that a number of cases arising out of the bonus given to munition workers have been referred by the Ministry of Labour to the Committee on Production or to the Special Arbitration Tribunal, and decisions have been given in five cases. The following have been found to be entitled to the bonus:—

Engineers, Moulders and Electrical Fitters, Mond Nickel Co., Clydach—Entitled to receive the $12\frac{1}{2}$ per cent. bonus.

Engineers and Ironmoulders, Baldwins (Ltd.), Panteg.—Entitled to receive the $12\frac{1}{2}$ per cent. bonus.

Several questions have arisen in regard to the classes entitled to the bonus, and two or three explanatory memoranda have already been issued. After considering the advice of the Committee on Production, the War Cabinet decided to adopt the following as a settlement of claims made in regard to the bonus:—

The $12\frac{1}{2}$ per cent. has been given, under existing orders and extensions made by the Admiralty and the Minister of Munitions, to workmen employed on munitions work (as defined in the Munitions of War Acts), and paid as plain-time workers, in engineering and boiler shops, foundries, shipbuilding, iron and steel trades, electricity generating stations, electrical contracting trades, brass foundries and works, hollow-ware trade, spring making and hot stamping works, tube works, wagon building, &c.

There is, however, a doubt as to whether the award applies to undertakings which are not certified under the Munitions of War Act, 1916, and it is possible that Mr. T. W. Cole's contention in our last issue that it does not is correct. Until undertakings have been notified that the award applies there is no reason to adhere to it strictly.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during December, 1917, and (*b*) the aggregate figures from Jan. 1 to Dec. 31, with increase or decrease compared with 1916:—

Electrical machinery, (*a*) £195,341 (increase £141,845), (*b*) £1,487,421 (increase £403,997); including generators and motors other than for aeroplanes, motor cars and cycles, (*a*) £9,984 (decrease £7,099), (*b*) £239,443 (increase £27,190); and electrical machinery unenumerated, (*a*) £185,357 (increase £148,954), (*b*) £1,247,978 (increase £376,807); telegraph and telephone cables other than submarine, (*a*) £81 (decrease £53,165), (*b*) £52,404 (decrease £76,446); telegraph and telephone apparatus, (*a*) £1,602 (decrease £1,785), (*b*) £32,328 (decrease £198,994); other electrical wires and cables, rubber insulated, (*a*) £1,669 (increase £1,486), (*b*) £35,756 (decrease £97,872); with other insulations, (*a*) nil (decrease £407), (*b*) £10,041 (decrease £5,132); carbons, (*a*) £2,259 (decrease £1,782), (*b*) £75,593 (decrease £4,434); glow lamps, (*a*) £17,517 (decrease £1,695), (*b*) £96,748 (decrease £182,058); arc lamps and electric searchlights, (*b*) £97 (increase £97); parts of arc lamps and searchlights (other than carbons), (*a*) £2,789 (decrease £21,589), (*b*) £112,569 (decrease £16,112); primary and secondary batteries, (*a*) £35,252 (increase £3,143), (*b*) £338,794 (increase £114,479); meters and measuring instruments, (*a*) £411 (decrease £2,310), (*b*) £33,462 (decrease £17,711); switchboards, (*a*) nil (decrease £110), (*b*) £561 (increase £184); electrical goods and apparatus unenumerated, (*a*) £37,962, (*b*) £546,366 (increase £167,952). Total of electrical goods and apparatus other than machinery and uninsulated wire, (*a*) £99,542, (*b*) £546,366 (increase £167,952).

Exports.—The exports of electrical machinery, material, &c., (*a*) during December, 1917, and (*b*) from Jan. 1 to Dec. 31, with increase or decrease compared with 1916, were as follows:

Electrical machinery, (*a*) £134,830 (decrease £30,783), (*b*) £1,489,727 (decrease £59,950), including railway and tramway motors, (*a*) £8,945 (increase £1,468), (*b*) £40,864 (increase £2,211); other generators and motors except for aeroplanes, motor cars and cycles, (*a*) £66,260 (decrease £33,135), (*b*) £813,441 (decrease £14,495); and electrical machinery unenumerated, (*a*) £59,625 (decrease £2,116), (*b*) £605,322 (decrease £47,667); telegraph and telephone cables, submarine, (*a*) nil (decrease £26,375), (*b*) £16,189 (decrease £231,603); other than submarine, (*a*) £35,901 (increase £[illegible]), (*b*) £[illegible],620 (increase £167,228); telegraph and telephone apparatus, (*a*) £1,763 (decrease £1,271), (*b*) £260,854 (increase £[illegible]); other electrical wires and cables, rubber insulated, (*a*) £1,025

(decrease £26,058), (b) £182,039 (decrease £363,997); with other insulation, (a) £19,271 (decrease £20,518), (b) £281,674 (increase £478,024); carbons, (a) £790 (decrease £92), (b) £22,929 (increase £12,520); glow lamps, (a) £6,784 (decrease £4,692), (b) £129,077 (decrease £63,443); arc lamps and searchlights, (a) £448 (increase £261), (b) £23,762 (increase £14,105); parts of arc lamps and searchlights (other than carbons), (a) £574 (decrease £204), (b) £75,293 (increase £52,598); primary and secondary batteries, (a) £34,417 (increase £16,901), (b) £172,543 (decrease £91,016); meters and measuring implements, (a) £9,112 (decrease £5,899), (b) £133,710 (decrease £75,038); transformers, (a) £4,305 (decrease £1,383), (b) £69,518 (decrease £34,334); switchboards, (a) £2,725 (increase £1,050), (b) £41,579 (decrease £17,036); electrical goods and apparatus unenumerated, (a) £51,667 (increase £2,734), (b) £691,870 (decrease £34,535). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (a) £187,785 (decrease £50,010), (b) £2,952,687 (decrease £1,131,329).

Tenders Invited and Accepted.

Turbo-Alternator and Condensing Plant.

The Corporation of the County Borough of NEWPORT, Mon., invite tenders for section 1, 3,000 kw. turbo-alternator, and section 2, surface condensing plant for 3,000 kw. turbo-alternator. Form of tender and contract, specification, &c., may be obtained from Mr. A. Nichol Moore, M.I.E.E., borough electrical and tramways engineer, Town Hall, Newport, Mon. Tenders by 10 a.m. Feb. 18 to Mr. Albert A. Newman, town clerk. *See also an advertisement.*

Railway Stores.

The MIDLAND RAILWAY CO. NORTHERN COUNTIES COMMITTEE (Ireland) require tenders by Feb. 7 for six or 12 months' supply of telegraph ironwork, wire, batteries, electric lamps, carbons, &c., castings, ironmongery, oils, &c. Forms of tender from the Stores Superintendent, York-road Station, Belfast.

Oil-Break Switches.

The PUBLIC WORKS OFFICE, WELLINGTON (N.Z.), require tenders by noon Feb. 5 for the supply of two Oil-break Switches for the Lake Coleridge power scheme. Specifications may be inspected at the Public Works Offices, Auckland, Christchurch, [illegible], and Wellington.

Telephone Material.

Tenders are invited by Feb. 27 for supply and delivery to the Postmaster-General's Department of South Australia of Telephone Material as per schedules 179 and 183. Specifications, &c., from the Commonwealth Offices, Australia House, Strand, London, W.C. 2.

DUNEDIN (N.Z.).—The tender of Turnbull & Jones has been accepted for the electric lighting of the new cathedral at £1,055.

Appointments Vacant and Filled.

A senior lecturer in electrical engineering is required for the Portsmouth Municipal College. Salary £200, rising to £250 by £10 annual increments. A workshop instructor in electrical engineering is also required at the College. Forms of application from the Secretary, Mr. H. E. Curtis. *See advertisement.*

A superintendent is wanted for a crucible steel foundry to take charge of about 60 men. *See advertisement.*

Northwich Electric Supply Co. (Ltd.) require an engineer and secretary. Applications to the Chairman. *See advertisement.*

Birmingham Tramways Committee require a workshop superintendent. Commencing salary £400, rising to £500 per annum. Applications to General Manager by Feb. 5.

Applications are invited for the post of Head of the Department of electrical engineering and physics of the Victoria Jubilee Technical Institute, Bombay. Salary Rs. 700. Applications by March 31, 1918, to Mr. D. E. Wacha, Honorary Secretary of Board of Trustees, Byculla, Bombay, India.

The Electric Supply Committee of Birmingham Corporation has appointed Mr. Frank Forrest chief assistant electrical engineer to the electric supply department. There were [illegible] applicants. Mr. Forrest has held the position of sub-station engineer in the City of Birmingham Electric Supply Department for the past [illegible] years.

Business Items.

The London address of Messrs. [illegible] of Huddersfield, is [illegible] London, W.C. 2. Telephone: Central [illegible]. Telegrams: [illegible] London.

Plant for Sale.—[illegible]

inspect can be obtained from Mr. Charles G. Henzell, M.Inst.C.E., waterworks engineer, 26, Great George-street, Leeds. Offers to the chairman of the Waterworks Committee, Town Clerk's Office, Leeds, by noon Feb. 11.

Liquidations.

A meeting to receive an account of the winding-up of Morris & Lister (London) (Ltd.) will be held at the offices of Messrs. Sugden & Hextall, 36, King-street, Cheapside, London, E.C., on March 8.

A meeting of creditors of the Auxiliary Electrical Co. (Ltd.) (in vol. liq.) will be held at 381, Salisbury House, London Wall, London, E.C., on Feb. 4. Claims to Mr. F. R. Reeves, Salisbury House, London Wall, E.C.

The first meeting of creditors of Wm. T. [illegible], electrical and mechanical engineer, Victoria-street, and [illegible], Bolton, will take place on Feb. 6 at the O.R.'s, Byrom-street, Manchester, and the public examination on Feb. 13 at the Court House, Mawdsley-street, Bolton.

[illegible] County Court, on Jan. 24.

Municipal Accounts.

Marylebone (London).—The revenue statement of the Electric Supply Committee for the quarter ended June last gives the following particulars:—

Revenue from sales of energy (including meter rentals) £33,730 (compared with £31,948 in the corresponding quarter of 1916), and expenditure, including working expenses, £19,434 (£17,517). The result of the quarter's trading was a surplus of £17,722 (against £17,945) towards meeting capital charges. Units sold were 3,598,200 (3,177,038). Costs per unit sold were 1·274d. (1·305d.)

The revenue statement for the quarter ended Sept. 30 last shows a credit balance of £14,539 (compared with £14,405 on the corresponding quarter of 1916) to meet capital charges, depreciation, &c. Revenue was £36,531 (compared with £35,856). Units sold were 2,729,641 (2,[illegible]) for private supply, and 143,667 (143,623) for public street lighting.

Paisley.—The accounts of the electricity department for the year ended May 15 show gross capital expenditure £253,097 (increase £1,972), of which £176,199 is outstanding.

Revenue was £32,477 and working and general expenses were £17,890, leaving gross profit £14,587. Loan charges were £12,777 and interest on bank overdrafts required £96, total £12,873. And after taking into account property and income tax, [illegible], there is a surplus for the year of £1,778. Maximum supply demanded was 2,597 (2,502) kw. Total connections are 238,937 [illegible] 23,816. Units generated were 5,702,900 (5,406,279) and sold [illegible] 4,629,847 (4,401,[illegible]).

Reading.—The accounts of the tramways department for the year ended March 31 show gross capital expenditure £230,789 (no increase), of which £140,445 is outstanding.

Total revenue was £44,597, compared with £41,087 in previous year; working and special expenses were £25,950 (£22,642), and gross profit, after adding bank interest, &c., was £18,648 (£18,454). Interest on loans £6,678 (£6,691), sinking fund £5,062 (£5,062), and income tax £[illegible] ([illegible]), leaving net profit £6,723 (£6,232), of which £[illegible] [illegible] has been contributed in aid of rates and £1,723 (£2,232) [illegible] reserve and renewals fund. Average total receipts per car mile, [illegible] net receipts, was 11·73d. [illegible], including working [illegible] and [illegible] power, but not [illegible] allowances and war [illegible], were [illegible]. Passengers carried were 10,919,[illegible] ([illegible]) and [illegible] 912,258 (921,[illegible]).

Southwark (London).—The accounts of the [illegible] electricity department for the year ended March 31 last show gross capital expenditure £148,000 (increase £[illegible]), of which £101,[illegible] is outstanding.

Income was £23,[illegible] [illegible] £22,[illegible] [illegible] [illegible] [illegible] sold 2,526,310 (2,661,060). Total maximum supply demanded was [illegible] ([illegible]) kw.

Wallasey.—The accounts of the [illegible] department for the year ended March 31 show gross capital expenditure £[illegible] (increase £[illegible]), of which £[illegible] [illegible]

[illegible]

Warrington. The accounts of the electric supply undertaking for the year ended March 31, 1917 show gross capital expenditure £138,334 (increase £5,836), of which £94,072 is outstanding.

Revenue was £41,203 compared with £34,403 in previous year, working and general expenses were £28,577 (£24,213), leaving gross profit £12,626 (£10,189), and net profit was £4,171 (£2,394). Average prices obtained were, public lighting, 2·11d. (2·51d.), private, 1·31d. (1·30d.), and traction, 1·70d. (1·59d.), and total costs were 0·889d. (0·782d.). Units sold, exclusive of traction, were 5,489,749 (4,578,294).

Wellington (N.Z.).—The accounts of the electric lighting department for the year ended March 31 last show total capital expenditure £227,[illegible]. The sinking funds total £27,736, of which [illegible] has been invested by the Commissioners.

Revenue was £79,472 (compared with £67,623 in previous year), working expenses were £34,722 (£28,508), interest and sinking fund required £10,343 (£19,327), depreciation £7,815 (£7,871), and special appropriations £10,334 (£10,359), leaving net credit balance £16,258 (£10,558). Total units sold were 4,505,694 (3,865,486). Average revenue was 4·09d. (4·15d.) per unit sold, working expenses were 1·85d. (1·77d.), and capital charges 0·97d. (1·13d.).

Tramway capital expenditure is £752,455. Revenue was £207,946 (compared with £187,864 for previous year), working expenses were £145,385 (£118,817), and capital charges £43,601 (£41,927), leaving net surplus £18,960 (£27,120). Revenue from power supply was £15,440 (£12,763), and the net surplus £1,729 (£1,305), the net surplus from tramways and power supply combined being £20,689. Passengers carried were 32,206,168 (28,687,773).

The tramways, power supply and public lighting sinking funds total £85,114, of which £5,293 has been applied in repayment of loans, and [illegible]

New Companies, Mortgages and Charges, &c.

New Companies.

PEBEO ACCUMULATORS (LTD.) (149,429.)—Private company. Reg. Jan. 22, capital £1,000 in 1s. shares, electrical engineers, manufacturers of and dealers in electrical apparatus, &c. Reg. office: 11, Queen Victoria-street, E.C.

C. C. WAKEFIELD & CO. (LTD.) (149,435.)—Private company. Reg. Jan. 23, capital £250,000 in £1 shares, to take over business of oil refiners, manufacturers of and dealers in lubricating oils, &c., carried on by C. C. Wakefield & Co., also to carry on the business of exporters and importers of lubricants, chemicals, &c.

Mortgages and Charges.

LEON CORNELIS (LTD.)—Assignment of £1,182 book debts, dated Jan. 1, 1918, to secure £1,237 to Robert Banking Co., 205, Strand, W.C. (The Robert Banking Co., Ltd., are directors of the company).

MONOMETER MFG. CO. (LTD.)—Notice of appointment of H. T. E. S. Ledsam, 16, Waterloo-street, Birmingham, and W. E. Withnall, 19, Temple-street, Birmingham, as receivers of the property comprised in first mortgage debenture for £10,000, dated Aug. 1, 1917, has been filed.

SIEMENS BROTHERS & CO. (LTD.)—Trust deed dated Jan. 15, 1918, [illegible] Company's undertaking and property, present and future, as a second floating security (subject to [illegible] deed dated 1900). Trustees: C. C. Macrae and C. B. Crisp.

City Notes.

BRUNNER MOND & CO. (LTD.)—The directors have prepared a [illegible] two [illegible]

EAST LONDON RAILWAY.—[illegible]

GREENWOOD & BATLEY (LTD.)—[illegible]

METROPOLITAN RAILWAY CO.—[illegible]

[illegible] LIGHT, HEAT & POWER CO.—[illegible]

STOCK EXCHANGE NOTICE.—[illegible]

The Round Table.

By "kVA."

THIS WEEK'S CHESTNUT. A certain engineering firm requiring a number of nuts for a Government job applied to the M. M. for permits to obtain them. In due course a budget of forms was received and returned duly filled in. Back came a notification that as part of the job was for the Admiralty and part for the War Office, more forms must be filled in. In due course came the reply that so far as the Admiralty was concerned the matter was in order, but the War Office stated that a part of the job appeared to be a matter for the Food Controller's Department and would the firm kindly fill in more forms and send them to this official. After some delay the Food Controller wrote that the matter was quite O.K., but would the applicant fill in a final form specifying whether the nuts wanted were brazils, barcelonas, walnuts or filberts!!

* * * *

An astronomical correspondent asks me to utter a word of cheer to "Round Table" readers in these days of air raids. He points out that while the Earth has only one moon, Saturn and Jupiter have ten and nine respectively! What a time they must have if all the "blinkin'" moons come out at once!

* * * *

From the "Evening News" I take the following as typifying Yankee technical slang:—

From a flying friend:—Freshly arrived, an American airman mistook a British aerodrome for his own. Down he flew, and landing near a vision in red and gold, who was deep in the intricacies of polishing an eye-glass, led off with, "Say! Are you the big noise of this joint?"

"I'm the commanding officer," was the reply, "if that's whom you are seeking."

"Well," said the American breezily, "that's the guy I'm looking for. I thought I'd blow along an' tell you I'd jest spread my gasoline plant along your grass plot."

* * * *

The following appeared in the "Daily News," and comes from the other side of the Atlantic:—

My Tuesdays are meatless,
My Wednesdays are wheatless,
I am getting more eatless each day.
My home it is heatless,
My bed it is sheetless,
They're all sent to the Y.M.C.A.

The bar-rooms are treatless,
My coffee is sweetless,
Each day I get poorer and wiser.
My stockings are feetless,
My trousers are seatless,
My, how I do hate the Kaiser!

* * * *

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, Jan. 29, 1881.]

ATLANTIC CABLES. It is now generally acknowledged that since Jay Gould has come to terms with the rival company in America the Atlantic Cable scheme will not be carried out.

LONDON FIRE TELEGRAPHS. Capt. Shaw states that in his report for the past year that the electric fire alarm system has conveyed nearly as many false calls as good calls. One offender, caught tampering with a fire post, was sentenced to 14 days' hard labour, and this, Capt. Shaw remarks, has had a satisfactory deterring effect.

THE ELECTRIC RAILWAY AT BERLIN. Owing to the severe weather prevailing for a fortnight past, the works upon the Berlin Electric Line have been much retarded, and cannot be resumed until a thaw sets in. The carriages of the Electric Railway will convey 20 passengers each. There will be seats for 12, and standing room for the remaining eight. The dynamo-electric machine will be placed between the axle trees and the floor of the carriage. The rate of travelling will be greater than that usual on tramways, and is expected to reach about 20 miles an hour. Powerful brakes, combined with an arrangement acting on the electrical apparatus, will enable the official in charge to bring the carriage to an almost instantaneous standstill.

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

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CONTENTS.

Notes.

Electric Omnibuses at Lancaster.

Owing to the unsuccessful working of electric omnibuses in London some years ago this type of vehicle has been under somewhat of a cloud. At the time it was felt that the withdrawal of these vehicles was rather due to finance than to technical difficulties, and it is therefore interesting to note the results now being obtained at Lancaster. In the London omnibuses, lead cells of the ordinary traction type were, of course, employed. At Lancaster, however, Edison cells are in use, and therefore more favourable results are to be expected. Upon looking at the various items of expenditure, it is noticeable that power is charged at 1·7d. per kilowatt hour, which is certainly on the high side, even in these days, for an off peak load. If the more recognised charge of 1d. per kilowatt-hour were charged the results would be more favourable. Even so results of six months working with two vehicles show a gross profit of £636 11s. 2d. Perhaps a weak point is the position [illegible] the absence of any charge for management, but this may be set off to some extent by the high charge for power. In cases of this kind the net profit depends very largely upon the figure that is adopted for depreciation. We are glad to note that interest has been taken at 5 per cent. and depreciation on a five years' basis, making a total of 22 per cent. per annum on the capital outlay. It should certainly be possible to realise a figure of this kind. It is interesting to note that the energy used per car-mile works out at about 1·1 kw.-hour. The weight of the vehicles is not given, but so far as we can judge this figure appears to be reasonable, having regard to the [illegible] low energy efficiency of the Edison cell. Wages are kept down by working the cars on the pay-as-you-enter principle. Taken as a whole, these results must be considered as very promising and well worth the attention of local authorities.

The Organisation of Scientific Workers.

There is a general feeling at the present time in this country that scientific workers should protect themselves from undue exploitation. This idea has found expression in the attempts now being made to form the National Union of Scientific Workers, whose main object is to promote the "economic interests of its members." The membership of such a body might, obviously, be very wide. Again, there has recently been a movement to form the British Association of Chemists, and last Monday the Society of Chemical Industry called a meeting in London to consider this proposal. It was largely attended, but opinions on the subject were somewhat divided. Although the proposal only affects chemists, it is, nevertheless, of considerable interest to all scientific workers. As is well known, there is already in existence the Institute of Chemistry, which has done a great deal to improve the status of the chemist. That being so, it may be said that the promotion of any other body requires some explanation. Upon reflection, we think it will be admitted that the present position is largely due to the fact that the Institute of Chemistry has not received the full measure of support which it deserves. The reason for this is, we believe, due to the inherent laziness of human nature. There is a general desire not to do more than is necessary, and this attitude has been supported by professors of chemistry. The idea has been held that a university degree in chemistry was good enough, and, therefore, further time should not be wasted in examinations. Considering the fact, however, that the examinations held by the Institute are wholly practical, and, therefore, give a standing which is quite distinct from that of a university graduate, we see no reason for this attitude. But once the young chemist fails to take such an examination before branching into research or into industrial chemistry it is pretty certain that he will never find an opportunity to take it later on. In due course he regrets the omission, and then a position like that now disclosed arises, and a desire is expressed to form another association, or, alternatively, an extension of the activities of the Institute of Chemistry.

The Objects in View.

Among [illegible] the legal re-definition of the term "chemist." Undoubtedly this is very desirable; but the Institute, in obtaining its Charter, failed many years ago to attain this object, chiefly due to the opposition of the Pharmaceutical Society. This short-sighted policy has led to increasing confusion, and we fear that this difficulty will now never be rectified, any more than the proper limitation of the term Engineer. Apart from this object, however, the programme of the proposed Association is not clearly defined. We imagine that, in practical language, the main object would be to improve the salary of the chemist. This also is desirable, but in that case the [illegible] to make some compromise in order to avoid the formation of a new society, the Institute widening its scope for this purpose. [illegible]

those who are undoubtedly well qualified from practical experience, but also those who may be accepted as chemists according to some definition. From the point of view of bringing pressure to bear upon Government departments, it is undoubtedly desirable to have the organisation as wide as possible. From this standpoint we are inclined to think that much would be gained by the Institute of Chemistry starting a register pure and simple of all chemists having certain qualifications, but such registration to carry no distinguishing letters. The A.I.C. and F.I.C. would remain as hitherto. But whether this is possible under the Charter we do not know. It is certainly desirable to avoid the multiplication of societies, and for this reason we suggest a compromise.

"Faraday House Journal."—The "Faraday House Journal" for the Lent term of 1918 includes obituary notices of Lieut.-Col. R. W. Hammond, Sec.-Lieut. E. B. Ritzen and Private W. C. Radford. The notes are chiefly concerned with the doings of old Faradians who have joined the Colours.

Royal Society.—At the meeting held yesterday Papers were read on "The Photo-Electric Action of X-Rays," by Prof. O. W. Richardson, F.R.S.; "The Parent of Actinium" by Prof. F. Soddy, F.R.S., and Mr. J. A. Cranston; "Some Problems in the Theory of Radiation," by Prof. Arthur Schuster, Sec. R.S.; and "The Absorption of the Radiation emitted by a Palladium Anticathode in Rhodium, Palladium and Silver," by Mr. E. A. Owen.

Economy in the Use of Coal for Heating.—A circular issued by the State Council of Defence, in Illinois, U.S.A., and based on recommendations of the University of Illinois Engineering Experimental Station, furnishes a number of hints to those concerned with the use of coal for heating purposes, with a view to economy in its use. The desirability of central heating equipment for buildings is pointed out, suggestions are made regarding the selection of dampers, the treatment of the fire box and smoke pipe, and the desirability of preventing inrushes of cold air. A number of rules are laid down for the operation of house heaters.

War Service of American Engineers.—We referred some time ago to the action taken by the leading engineering and scientific societies in the United States, in preparing lists of [illegible] who were in a position to assist the Government on technical matters in relation to the war. We observe in the "Electrical World" a list of 336 engineers who have received commissions as captains or a higher rank in the Army or Navy. The names are taken from the lists of the American Institute of Electrical Engineers and the American Society of Mechanical Engineers. We are glad to see that the authorities in the United States are taking advantage of these offers of technical assistance.

Royal Institution.—At a general meeting of the members of the Royal Institution, held on the [illegible] inst., the managers reported that Dr. Mond, under the [illegible] and deed of trust of the Davy Faraday Research Laboratory of the Royal Institution, [illegible] to the Royal Institution before [illegible] the sum of [illegible] endowment fund. The [illegible] Davy Faraday Research Laboratory [illegible] Fund. This will add [illegible] for the purposes of [illegible] of the Davy Faraday Research Laboratory [illegible] of original research in chemical and physical science.

British Engineering Extensions in China.—The "Journal" of the Royal Society of Arts gives a summary of a lecture recently given by Mr. A. Rose, H.M. Commercial Attaché at [illegible], before the London Chamber of Commerce on "The Prospects of British Extension in China." Mr. Rose stated that China offers a fine field for many forms of engineering enterprise, especially for textile machinery in the cotton growing districts, for electric light and power plants, for pumps, motors and all machinery essential to industrial enterprise. At present there are only 87 electrical installations in China, a considerable number of which were secured by the Germans in consequence of their co-operative system. In a country like China, where there is little knowledge of mechanical power, careful methods of education are very necessary, and information must be supplied showing how the machinery can be utilised, where they can obtain it, and what profits will ensue from its adoption.

A Method of Testing Current Transformers.—We have received a new publication of the Bureau of Standards (Scientific Paper No. 309), entitled "A Method for Testing Current Transformers," by Mr. F. B. Silsbee. A general method is outlined in this Paper for the determination of the ratio and phase angle of current transformers in terms of the constants of previously calibrated standard transformers of the same nominal ratio. Such methods are essentially more sensitive, or, conversely, may be used with much less sensitive instruments, than the laboratory methods now in use for the absolute determination of the ratio and phase angle of a single transformer. Two of the most convenient of the many possible modifications of the general method are described in detail. It is hoped that the methods will be found useful in commercial plants where delicate laboratory equipment is not available, and where large numbers of transformers must be tested rapidly and with moderate accuracy. This Paper is now available for distribution, and those interested may obtain a copy by addressing a request to the Bureau of Standards, Washington (U.S.A.)

Researches on Electric Lamps During 1917.—A report of the Committee of progress of the American Illuminating Engineering Society, prepared for the Convention last autumn, contains some notes on developments in electric lamps during the past year. On the whole no striking advances are recorded though it is possible that dormant researches may come to life when the war is over. Progress has been more in the direction of standardisation, one rather curious fact being the development of a complete line of 32-volt incandescent lamps ranging from 5–40 watts, intended for outfits in homes lighted by storage batteries. Attempts are still being made in Germany to exploit the not very promising device of introducing mercury into the bulb of a carbon filament lamp with the object of increasing its efficiency. Another German process relates to the squirting of tungsten wire, only a few hundredths of a millimetre thick, from a mixture of powdered tungsten ore 2 per cent. of thoria, and suitable binding agents. Another proposition, made in the United States, is to use crimped ribbon of tungsten, instead of the ordinary coiled tungsten filament, for very high candle-power lamps; in this way a large surface and a less fragile arrangement may be anticipated. In the arc lamp field various methods are discussed of avoiding the troublesome slag deposits on the craters of arc lamps. When positive carbons containing 30–40 per cent. of luminous salts are used, the addition of 3–5 per cent. of boracic acid is said to be helpful.

"The Central."—The last issue of "The Central" (Vol. XIV., 1917) contains several readable articles by old students at the City and Guilds Engineering College, South Kensington, and the usual notes on careers and recent activities of old Centralians. Among the longer articles we note those by L. Kaye, on "The Amritsar Hydro-electric Pumping Scheme"; by R. A. S. Thwaites, on "The Heat Treatment and Testing of Alloy Steel for Aero Engines"; and by E. H. Rodd on "Recent Crystallographic Work at the Central Technical College." "The Mental Side of the Human Industrial Element," by "Another Works Manager," is supplementary to a contribution which appeared last June and emphasises the value of the co-partnership methods adopted, among others, by the South Metropolitan Gas Co., and by various concerns in Denmark. The Old Student Notes in the present

circumstances inevitably make rather sad reading, with their record of so many promising lives cut short. Among those who have fallen we note Acting Captain R. O. Beit, Sec.-Lieut. E. T. Boyes, Sec.-Lieut. T. J. Hornblower and Sec.-Lieut. C. D. McCourt, portraits of whom are included. We observe that J. E. Montgomery, now a captain in the R.G.A., has been obliged to relinquish the editorial duties which he ably undertook for many years; but the present editors are to be congratulated on maintaining the general standard of readability, scientific value and finish of the journal, in spite of all the difficulties incidental to the war.

Trade Parliaments.—A pamphlet has been issued by the Industrial Reconstruction Council on the subject of Trade Parliaments and the establishment of Industrial Councils, as recommended by the Whitley Report. The urgency of the problem is emphasised, and it is pointed out that organisation on these lines will enable industry to be responsible for its own development. It is evident that a movement in this direction will not be welcomed by Germany, as competition with the manufacturers of this country will then be less easy. This is clear from the following translation of comments in the "Munchner Neueste Nachrichten":—

The attempts made by the English to reform industry deserve consideration by us also, since in the great struggle after the war that nation will certainly come off best which carries over unimpaired from the war period into peace the ideal of work for the common good, and which takes due account not only in politics but in the organisation of the industry, of the self-consciousness of the people which has grown so immensely during the war. Without losing sight of our own special circumstances we have every reason to follow with the greatest attention the development of the situation in England.

The above is a good testimonial to the value of the Whitley Report. The great advantage of Industrial Councils is that capital, management and labour will all be brought closely into touch with one another. A number of subjects are mentioned as coming within the sphere of these Councils, including demobilisation, apprenticeship, supply of raw materials, the avoidance of confusion in the transition period after the war, research, education and the development of export trade. The establishment of such Councils should introduce co-operation where hitherto there has been far too much antagonism, and will enable each industry to develop along its own lines. In conclusion, some suggestions are made as to the lines to follow in establishing a joint standing Industrial Council in any industry. A good deal of discussion necessarily precedes this step, and in this connection the Industrial Reconstruction Council will be pleased to arrange for some member to attend and to give particulars of similar movements and negotiations in other trades or to furnish draft schemes. Copies of the pamphlet can be obtained from the secretary of the Industrial Reconstruction Council, [illegible], Bouverie-street, London, E.C. 4.

Obituary.

DEATHS ON ACTIVE SERVICE.—The following deaths are reported: [illegible]

[illegible] at Burnley electricity works, has been killed in action.

Personal.

On Feb. 7, Mr. [illegible]

[illegible]

WAR HONOURS.—The following honours have been granted:—

The Military Medal has been conferred upon Pte. James Brixey (R.B.), an employee of Messrs. A. P. Lundberg & Sons, for bravery under shell fire.

Sergt. W. Willis (London Regt.), formerly in the Burnley and Torquay tramways department, has also been awarded the Military Medal.

Arrangements for the Week.

FRIDAY Feb. 8th (to-day).

PHYSICAL SOCIETY.

5 p.m. At the Imperial College of Science, South Kensington, London, S.W. Annual General Meeting. Papers to be read "A Recording Thermometer," by Prof. C. V. Boys, F.R.S., "The Primary Monochromatic Aberrations of a Centred Optical System," by Mr. S. D. Chalmers, M.A.

ROYAL INSTITUTION.

5.30 p.m. At 21, Albemarle-street, London, W. 1. Discourse on "Science and Ethics," by Principal E. H. Griffiths, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, STUDENTS' SECTION.

7 p.m. At Faraday House, Southampton-row, London, W.C. Paper on "Magnetos," by Mr. R. W. Corkling.

JUNIOR INSTITUTION OF ENGINEERS.

8 p.m. At 39, Victoria-street, Westminster, London, S.W. Paper on "A Simple Scheme of Works Organisation," by Mr. C. H. Woodfield.

SATURDAY, Feb. 9th.

BIRMINGHAM AND DISTRICT ELECTRIC CLUB.

7 p.m. At the Swan Hotel, New-street, Birmingham. Discussion on "The Decimal System," to be opened by Messrs. H. C. James-Carrington and J. M. Couch.

MONDAY, Feb. 11th.

INSTITUTION OF ELECTRICAL ENGINEERS, NEWCASTLE LOCAL SECTION.

6.45 p.m. At the Mining Institute, Newcastle-on-Tyne. Paper on "Telephone Exchange Transfers and their Organisation," by Mr. F. G. C. Baldwin.

TUESDAY, Feb. 12th.

INSTITUTION OF ELECTRICAL ENGINEERS, MANCHESTER LOCAL SECTION.

7 p.m. At the Engineers' Club, 17, Albert-square, Manchester. Paper on "Some Transient Phenomena in Electrical Supply Systems," by Prof. E. W. Marchant.

INSTITUTION OF ELECTRICAL ENGINEERS, YORKSHIRE LOCAL SECTION.

7 p.m. At the Philosophical Hall, Leeds. Paper on "Large Batteries for Power Purposes," by Mr. E. C. McKinnon.

ASSOCIATION OF SUPERVISING ELECTRICIANS.

7.15 p.m. At St. Bride Institute, Bride-lane, Ludgate-circus, London, E.C. Paper on "D.C. Motor Troubles," by Mr. E. F. Butler.

INSTITUTION OF ELECTRICAL ENGINEERS, SCOTTISH LOCAL SECTION.

7.30 p.m. At the Rooms, 207, Bath-street, Glasgow. Ninth Kelvin Lecture—"Kelvin as a Teacher," by Prof. Magnus Maclean.

JUNIOR INSTITUTION OF ENGINEERS.

[illegible] At the Mining Institute, Neville Hall, Newcastle-on-Tyne. Inauguration of a Local Section for the North-East Coast with Newcastle for its centre.

WEDNESDAY, Feb. 13th.

[illegible]

THURSDAY, Feb. 14th.

[illegible]

FRIDAY, Feb. 15th.

[illegible]

Electric Omnibus Results at Lancaster.

The Edison omnibus service at Lancaster commenced early in December, 1916, with two 22-passenger single-deck vehicles, whilst the third omnibus of similar type was in commission in January this year; and it is interesting to learn from Mr. J. B. Patterson, the acting borough electrical and tramways engineer, who is responsible for the innovation, that no involuntary suspension of the service has occurred during the whole period, but, on the other hand, the service was maintained right through heavy snowstorms, when the tramway service has been temporarily suspended until the track was cleared.

Fig. 1.—Showing Feeder Pillar for Boosting "Edison" Omnibuses and Passengers "Lined up" in Three Queues waiting for Omnibuses to Arrive.

The summary of receipts, expenditure and mileage, &c., herewith are for the first completed half-year with the full fleet in commission. It should be stated that the total mileage includes the "dead" miles between the depot and omnibus terminus, demonstrations to the Lancaster Corporation and to deputations from other Corporations, and sundry journeys for tyre repairs, &c. No tyre press being available in Lancaster at present, it is necessary to send the omnibus some 4 to 5 miles for tyre renewals, &c. To remedy this inconvenience the Corporation have authorised Mr. Patterson to purchase a tyre press, which he hopes to have installed very shortly; this will not only have the advantage of reducing "dead" mileage, but also reduce the heavy item for labour included in omnibus maintenance, which is mainly accounted for by the omnibus being sent on Sunday (the only convenient day), for which men's time is charged double rate. The material under the same heading includes a complete set of tyres for two omnibuses, which will not require further expenditure during the next half-year, so that this item will be correspondingly reduced when the average is taken over the full 12 months' running.

[illegible]

[illegible]

[illegible] further protecting the drivers from inclement weather whilst acting in their dual capacity of driver and conductor, the system adopted being "pay as you enter."

In this connection it is interesting to note that this system ha proved perfectly satisfactory in Lancaster, and the two new chassis ordered from the Edison Company (one of which was delivered a few weeks ago) are to be fitted with a novel type of body, with front entrance in line with dash board approached by circular steps in front of chassis on near side, the advantages claimed being a more convenient arrangement of the steps and additional seating accommodation, whilst the passengers have actually to pass the driver, thus facilitating the collection of fares. The closing of one door, operated by a lever from the driver's seat, makes the omnibus totally enclosed.

The two monthly returns, taken at random, giving passengers carried, &c., show the increasing popularity of the service; and it should be pointed out that the Skerton route is purely a normal service under average conditions, being over average roads and gradients to Beaumont Bridge, some 1½ miles from the centre of the town, for which the fare is 1d., whereas the Caton-road route is a "rush" service between the centre of the town and an industrial works. The same fare is charged, although the distance is slightly less; but the service is only maintained during "rush" periods, which, of course, accounts for the phenomenal earnings—in one case of 19·05d. per omnibus-mile.

Mr. Patterson has attained these eminently satisfactory results at a minimum initial expense, having in view the small fleet of omnibuses required at present and the difficulties of obtaining plant under existing conditions; but it must be obvious that an increased service running under suitable and normal conditions would show an increased margin of net profit. The fact that the redemption is over such a short period and the rate of interest excessive are factors over which Mr. Patterson has no control.

The capital charges on the specially constructed boosting station and garage charging arrangements would automatically decrease as the fleet was augmented.

A new scheme, well investigated and planned so as to attain the

Fig. 2.—No. 1 Omnibus Leaving "Loaded to the Step" with Munition Workers, 7.15 A.M.

most economical running costs, would not only show a handsome return on the capital outlay—indeed, that fact is amply demonstrated by the above returns—but, in addition, would prove a valuable "off peak load" customer to any electricity undertaking.

We are indebted to Mr. J. J. Hargreaves, provincial representative of Edison Accumulators (Ltd.), for these interesting particulars.

Table I.—*Summary of Receipts, Expenditure, Mileage, &c., for First Half-year, April 1 to September 29, 1917.*

	£	s.	d.	£	s.	d.
Current, 31,503 kw.-hours at 1·7d.	223	2	11			
Drivers' wages	187	5	3			
Omnibus maintenance, wages	35	0	8			
,, ,, material	123	11	0			
Machinery maintenance, wages	8	10	5			
,, ,, material	10	11	7			
Cleaning, wages	10	14	7			
,, material	0	19	0			
Clerical (proportion of wages)	3	3	0			
				602	18	5
Special (fixing wind screens, &c.), wages	2	11	8			
,, ,, ,, material	20	19	8			
				23	11	4
Total expenses	£626	9	9			
Receipts	1,277	3	11			
Gross profit	650	14	2			
Capital charges	390	0	0			
Surplus	260	14	2	(260	14	2)
Total miles run	22,257					
Average receipts per mile	13·8d. per mile					
Total costs per mile	10·09d.					

Table II.—*Monthly Returns.*

Week ending. 1917.	Skerton route. Pssgrs.	£	s.	d.	Caton-road. Pssgrs.	£	s.	d.	Total. £	s.	d.
April 21	4,612	19	4	4	5,943	24	15	3	43	19	7
,, 28	4,470	18	12	6	5,858	24	8	2	43	0	8
May 5	4,870	20	5	10	5,581	23	5	1	43	10	11
,, 12	4,851	20	4	3	5,696	23	14	8	43	18	11
	18,803	78	6	11	23,078	96	3	2	174	10	1

Omnibus mileage, Skerton route	1,785
,, ,, Caton-road route	1,557
Total mileage	3,342
Receipts per omnibus-mile, Skerton	10·53
,, ,, ,, Caton-road	14·82
,, special journey, Caton-road	£0 11 0
Total average receipts per omnibus-mile	12·58
Drivers' wages	£28 11 9
Current, 5,077 units at 1·7	£35 19 3

Week ending. 1917.	Skerton route. Pssgrs.	£	s.	d.	Caton-road route. Pssgrs.	£	s.	d.	Total. £	s.	d.
Oct. 27	5,937	24	14	9	8,326	34	13	10	59	8	7
Nov. 3	5,936	24	14	8	7,882	32	16	10	57	11	6
,, 10	6,325	26	7	1	7,926	33	0	6	59	7	7
,, 17	5,561	23	3	5	7,407	30	17	3	54	0	8
	23,759	98	19	11	31,541	131	8	5	230	8	4

Omnibus mileage, Skerton route	1,849
,, ,, Caton-road route	1,692
Total omnibus miles	3,541
Receipts per omnibus-mile, Skerton route	12·85d.
,, ,, ,, Caton-road route	19·05d.
,, (special journeys, Caton-road route)	£3 0 6
Drivers' wages	£31 6 7
Current, 5,543 units at 1·7d.	£39 5 3
Total average receipts per omnibus-mile	15·77

Long-Distance Transmission in Germany. In view of the proposals recently made by the Reconstruction Committee for the extension of electrical supply in this country, involving long-distance transmission, some data given by Mr. F. Niethammer in a recent issue of [illegible] are of interest. The author gives some particulars of the generation of electricity in Germany, which in 1916 amounted to [illegible] kw.-hours, as compared with [illegible] kw.-hours in 1913, and discusses a possible [illegible] network covering the entire country. The potentialities of water power in [illegible] represented in Austria and Germany, and schemes are being projected for the utilisation of a large part of the power to be derived from waterfalls in the Austrian Alps. It is also stated that in the near future Germany aims at the complete electrification of all her railways and the erection of [illegible] stations using power derived both from water and from the exploitation of her large fields of turf and brown coal. A still further development in the general industrial use of electricity in large cities for heating, lighting and power is considered probable.

Telephone Exchange Transfers and Their Organisation.

The following discussion took place upon Mr. F. G. C. Baldwin's Paper on the above subject at the meeting of the Institution of Electrical Engineers on Thursday, January 24th, an abstract of which was given in our issue of February 1st.

Mr. J. A. STUBBS (Assistant Engineer-in-Chief, G.P.O.) said he was glad Mr. Baldwin virtually dismissed the idea of transferring each line or group of lines independently, and preferred transferring the whole of the lines at one operation. This was so much in consonance with generally accepted conditions that often if there were two exchanges to be transferred and combined into one it was still good practice to arrange that both should be transferred simultaneously. The transfer of the line plant by teeing from underground or from underground and overhead, indicated by Mr. Baldwin, was undoubtedly very sound practice wherever it could be applied. Teeing lines at the old exchange might be much more open to question. It did not seem to prevent any appreciable advantage in arranging for the transfer to exclude that exchange. With regard to the suggestion of transferring via the new exchange, he did not know that that had been applied in any case of considerable importance. It looked as though it would be somewhat expensive, because it involved that the cabling of the main distribution frame at the new exchange should contain at least double the capacity of the existing exchange lines that had to be transferred. Mr. Baldwin did not seem to much like the scheme of transfer that he described for use when line plant was limited. That condition appealed to him (Mr. Stubbs) as having considerable attractions. This system having been developed into a practical scheme, he thought it was also sound from the financial aspect as being economical, and in spite of the difficulties Mr. Baldwin indicated, he thought it would still be well to maintain it as a recognised procedure. It was certainly advisable to inspect in advance the apparatus at the private branch and switchboards, as the operators were thus made familiar with the idea of the change before it occurred. As regarded the transfer for an ordinary subscriber, there was the qualifying condition that with a transfer to an automatic exchange it was impossible to leave the old instrument by itself, as it was necessary to have the usual calling device on the automatic exchange system.

Mr. A. MOIR said the Paper brought out the great difference between the heavier and the lighter sides of electrical engineering. The power engineer connected a consumer to his leads which ran along the street by merely tapping into the premises: but in the connection of a telephone subscriber the procedure was much more complicated, and this fact accounted for the wealth of detail Mr. Baldwin had been obliged to introduce into his Paper. In case of a break also the telephone engineer's difficulties were very considerable. Recently, in the subway at Piccadilly circus, a gas explosion occurred, followed by creeping fire. About four main cables were seriously damaged, and before normal conditions could be restored 19,000 separate wires had to be repaired. With regard to the question of the separation of the relay contacts by fibre separators for the purpose of the transfer, he preferred a small wooden peg under the spring of the relay. It did not interfere with the contact points and obviated the danger of leaving small portions of fibre on the contacts. The fittings should not be delivered at a new exchange until the bricklayers and plasterers had been cleared out or until the walls were perfectly dry. Nothing so quickly lowered the insulation of the multiple as damp walls, and nothing was so destructive of the highly polished switch fittings and the delicate contacts in the relays as bricklayers' dust. A transfer should never be rushed [illegible] its completion the engineer should reserve the right to extend it by, say, three weeks. [illegible]

Mr. F. S. E[illegible]

and th[illegible] connections had to be made without additional cable, there must be a watchman day and night. This was avoided by taking the cables inside the new exchange, as straight through joints could be made which did not have to be watched and guarded. However well the work of transfer might be carried out, there would be a large number of faults: but these should be reduced to a minimum. He was told that they could be got down to 0·5 per cent., and that was the result of going carefully into details before the transfer.

Mr. G. H. BRYANT said he was engaged on the transfer from magneto to central battery working of a number of the telephone company's exchanges between 1905 and 1910. With regard to the insertion of vulcanised fibre strips between the contacts of the relays, he thought that system was inferior to the one employed on the transfers to which he had referred. In 1905 and 1906 microscopic covered glasses were inserted between the contacts of the cut-off relays, then the subscribers' circuits were connected with the new and old exchanges in parallel until the transfer took place. The operators at the new switchboard momentarily plugged into all the subscribers' lines, so as to operate the subscribers' relays and enable the glasses to fall out. This was abandoned because some glasses did not fall out, and others broke and fragments lodged between the contacts and caused faults. Fibre was then tried, and it was found that a number of the contacts were insulated by small particles. Cardboard and paper gave similar results, and it was decided to separate the contacts by holding the armature in the operating position by means of a match (subsequently replaced by hardwood wedges) between the coil and armature. The hardwood wedges were used at Gerrard and various other transfers in the metropolitan area from 1907 to 1910. The author said where the protectors were provided with additional springs to admit of the insertion of the test plug without first removing the heat coils the new equipment might be separated from the old by inserting wooden plugs between the springs on the protectors. This had a disadvantage, as the multiple of the new exchange was not connected to the subscriber's lines prior to the time of transfer. It was the practice in the metropolitan area to connect the new and old exchanges for about a week before the transfer, and make the final test of subscribers' lines from the new exchange multiple, and the cut-off relays were not disturbed while such work proceeded. The bulk of the junction lines were connected to both the new and old exchanges for some days prior to the transfer, and the circuits on the new switchboard did not interfere with the working of the old exchange.

Mr. E. A. LAIDLAW said he had found more faults were experienced when paper, fibre or glass was used for the relays than when wood blocks were used. It was better to adopt some mechanical means. The method of transfer described by the author was good but expensive. He found that at a large centre, such as Manchester or Glasgow, subscribers could be informed that at a certain time their line would be cut for two or three hours, and, Saturday afternoon being chosen for the transfer, it was found at Manchester that out of 300 subscribers only about eight had to be kept going, and temporary arrangements made for them. Putting the exchange right through in that way saved a good deal of money. Were all the junction circuits put through in the manner described by the author, or only order wire and special long-distance junctions? For the junction lines between Gerrard and Bank, with underground cables, [illegible] were not employed.

Mr. J. F. EDMONDS said there would be a very large amount of this work to be done as soon as normal conditions prevailed, and the Paper would be of even more value then than now. Telephone engineers might question whether the enormous cost involved in carrying out the work [illegible] Paper was really justified. He supported the author's [illegible] the engineering point of view. [illegible] in the distant past without due regard to the service conditions and with terrible effect on the service. [illegible] but it had taken months and months to get back the service to the pre-transfer standard and to [illegible] the telephone service as a [illegible] capital to avoid things like [illegible] brought right into the [illegible] Mr. Bryant had said [illegible] in the new exchange in [illegible] with all trouble [illegible] at Victoria, and the [illegible] The traffic staff should [illegible] staff and the detail [illegible] should make [illegible] they might come from [illegible] The most [illegible] successfully but [illegible] junction circuits [illegible] the Paper. It [illegible]

Mr. [illegible]

Mr. [illegible]

a service; and the remainder, if possible, should be put through by ordinary plumbing and jointing work. It seemed a good scheme. The old practice in changing from magnets to central battery was to have condensers to the subscribers' apparatus and use the old appliances. That had never been the practice with the automatic. His colleague had introduced an advantageous system, in which there was no condenser in the subscriber's apparatus, and the old telephone was teed across.

Mr. HEADLEY said there was never any case where simultaneous transfer could not be arranged for. With regard to line plant alterations, the general standard in the Post Office was to use the teed underground-overhead scheme and the grouped line scheme. He did not know whether teeing via the new exchange could be called standard practice. Mr. Baldwin said the teeing of the line to the old exchange was undesirable. The objection to that was that a straight through joint must be made externally after the transfer, and to avoid interfering with the service it was desirable to make all one's arrangements in advance in regard to teeing with the old exchange. If the grouped line scheme were adopted, two subscribers' lines were used, one coming through from the old exchange to the new and the other continuing to the old exchange. Certain work had to be done in the manholes outside both these exchanges. A little sketch would be helpful if the author could supply it. When breaking into the new cable it was easy to provide bridging wires over the lines before disconnecting, and so avoid breaking the line down. A diagram showing the arrangement in the manhole outside the old exchange would be very useful. A diagram might show where the two cables, one coming from No. 1 and one from No. 2 subscriber, had been opened up. He (Mr. Headley) was probably responsible for introducing into the Post Office the method of teeing the telephone for automatic work, but it was used previously in America so far as direct lines were concerned. It did away with the expense of having the condenser to subscribers' lines and also with tests, and there was no new wiring. In connection with private branch exchanges, it was quite possible to arrange for the feeding-up current on the exchange line to be fed at the old exchange between the break jack, the test jack on the main frame and the protector itself. One could fit the terminal strip on the main frame, leading the jumper wire between the test jack and the protector, teeing them together temporarily and coupling from that slip to the repeating coil; the exchange side would go to the other side of the terminal strip. Then, when the transfer was made, the heat coils were taken out and the feed-up current to the old exchange disconnected. The whole of the work at private branch exchanges could be done before the transfer.

Mr. BALDWIN, replying to the discussion, said he agreed that the arrangement Mr. Stubbs approved for adoption when line plant was limited was a sound proposition in certain cases, but there were many cases in which a simpler method, which would cause little or no more expense, was preferable. His experience of the method of transfer with limited line plant between old and new exchanges was rather a sorry one. The cost entailed by that system during the 6 to 12 months of preparation for the transfer would exceed by far the annual costs for a number of years of the additional cable plant required. The cost of that system was high compared with the cost of the system for transfer from magneto to central battery exchange, also described in the Paper. There certainly was a danger that when using a fibric strip some of the fibre might adhere to the contacts and cause trouble, but he had not experienced it. He was sorry more had not been said about teeing, because that was one of the sources of trouble in the past. He agreed with Mr. Bynd that there was an objection to the method where three wires were used, the third wire being left still in the twist, but the method he (Mr. Baldwin) had suggested not only did away with that but facilitated the identification of the actual wire which had to be cut. Break-jacks in connection with junctions had been mentioned. All junctions did not pass through break-jacks, but in many cases such an arrangement could be put in at small cost. He had in mind a transfer where fibre strips were used and a test after the transfer did not show any faults on the relays from that cause. He agreed with Mr. Edmonds that everything that was possible should be done to prevent interruption of service, and he thought everything possible was usually done. It was impossible to cover all the matters referred to by Mr. Edmonds in a Paper of that length. If Mr. Headley would supply the sketches which he had suggested would be of interest they would doubtless be printed in the "Journal."

Diminishing Eddy-Currents in Turbo-Generators.—A recent American patent taken out by Prof. A. B. Field, and described in the "Electrical World," refers to a device for [illegible] the excessive heating that is apt to occur in the ventilating space of turbo generators. An annular laminated [illegible] of magnetisable material is located in the annular ventilating space, the path of lines of force entering the space being [illegible] diverted in a direction parallel to that of the lines of force traversing the field magnet and the magnetisable core [illegible]. In this way the fringe of magnetic lines into the sides of the vent space is largely prevented, and eddy currents eliminated to a corresponding extent. As an additional aid in accomplishing this result, a series of introgressively stepped portions of the core on each side of the vent is also provided.

Electric Drive for Cotton Mills.*

By J. E. MELLETT.

Summary.—The author discusses the power equipment of cotton mills, and states that in practically every case the electric motor, when supplied with central station service, shows the lowest operating costs, highest quality of product, and greatest production. In this article he discusses the advantages in general of electric driving, and gives detailed consideration to the application of the electric motor to the various machines and operations involved.

Thirteen years ago 1,100 motors aggregating 65,000 h.p. were installed in textile mills. At the present time approximately 60,000 motors totaling 850,000 h.p. have been installed up to January, 1916.

The owners of the mechanically driven mill adopt the electric drive primarily because it is more economical and convenient than other types of power. The architect for a new mill being built to-day rarely ever thinks of any other than electric power, and if central station service is not available installs generating equipment for electric drive. He is also aware of the saving due to the elimination of shafting, hangers, belting, &c., if electric drive is installed. The reason why mills discard the steam engine or turbine, therefore, is that they obtain (and admit) a lower cost per pound of goods produced.

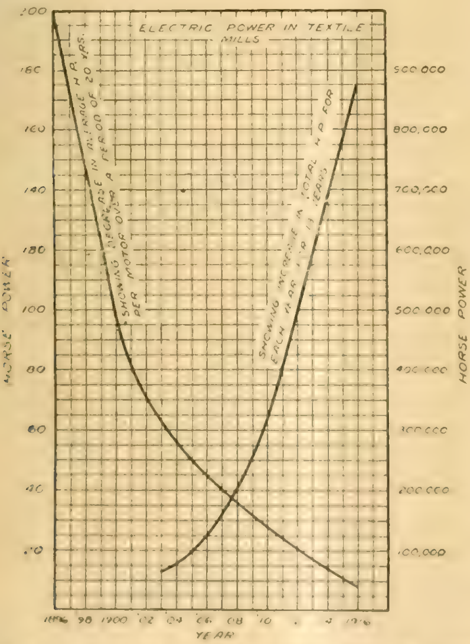


FIG. 1.—A COMPARATIVE CHART OF ELECTRIC POWER IN TEXTILE MILLS.

The average size motor installed in textile mills 20 years ago was over 200 h.p. and has been gradually decreasing, which is indicative that the mill men appreciate the advantages of placing the motor as close to the machine as possible. Fig. 1 shows the decrease in the average h.p. per motor and the increase in h.p. installed in textile mills from 1896 to 1916.

By the use of the electric drive the mill will secure an increase in production anywhere from 2 to 20 per cent., the ratio of percentage increase being dependent on the type of drive adopted and the type and condition of mill adopting it.

Increase in production by electric drive is secured through the maintenance of a more uniform speed on the producing machines, or doing more work in a given time and turning out the job longer and better than the present mechanically operated machine. The mill man cannot run the machines any faster, or secure any closer speed regulation on the [illegible]. The electric motor maintains at the machine a speed regulation as close or closer than the engine itself. The increase in production is not secured so much by the higher speed as by the more uniform speed maintained. A [illegible] item in spinning is the large number of breaks, which, to a certain extent, are due to the sudden start or jerk of the belt. When operated by the mechanical method the belt tries to take the entire load instantly. The motor, however, does not start with a jerk as its acceleration on starting covers a wider period of time; the speed gradually rises until it attains normal, thereby giving a smooth speed curve. The advantage of this method of starting the machinery over the old belt method is obvious, and is another instance where electric drive improves the quality of yarn.

In order to bear out the argument regarding the difference in speed regulation of the engine as compared to the speed variation at the machine, Fig. 2 shows a tachograph record of engine and

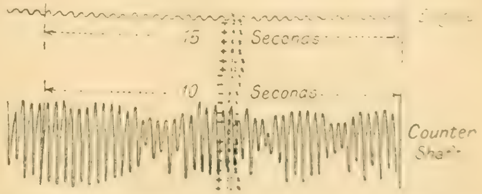


FIG. 2.—SPEED CURVES. VARIATION 3 PER CENT. AND 20 PER CENT.

countershaft speed, the countershaft driving looms. Fig. 3 shows the speed variation of an engine-driven line shaft operating preparatory machinery compared with the speed regulation obtained by the adoption of electric motor drive.

Fig. 2 shows conclusively that there is a variation in speed between the engine crank shaft and the machines operated, and Fig. 3 illustrates the fact that a higher average speed is maintained by the electric motor. Tests prove conclusively that in the average well-designed mechanically driven mills the speeds on spinning run from 3 to 15 per cent. below normal where they are not carefully

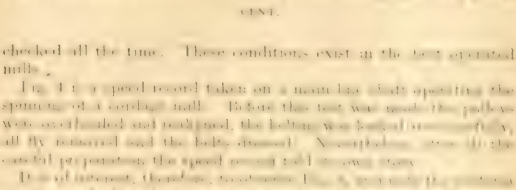


FIG. 3.—SPEED VARIATION, STEAM 7 PER CENT., ELECTRIC [illegible] PER CENT.

checked all the time. These conditions exist in the best operated mills.

Fig. 4 is a speed record taken on a main line shaft operating the spinning of a cordage mill. Before this test was made the pulleys were overhauled and realigned, the [illegible], all [illegible] removed and the belts [illegible]. [illegible] the speed record [illegible].

It is of interest, therefore, to compare Fig. 5, showing the [illegible] speed record after electric motors were installed.

It may now be well to discuss briefly the power requirements and how the electric motors are applied.

POWER REQUIREMENTS AND ELECTRICAL EQUIPMENT.

Cotton mills generally can be subdivided into three classes, namely, coarse goods spinning up to 18's, medium goods 18's to 40's, and fine goods above 40's. [illegible] required to drive a mill is determined by the number of spindles, speeds, counts spun, class and grade of goods manufactured. The [illegible] per hour [illegible] about 2[illegible]

* Abstract of an article in "The General Electric Review" (U.S.A.).

If the average indicated horse-power of the engine is used to determine the number of spindles per horse-power in a specific instance, as compared with the result obtained by using the total connected electrical horse-power, it will be found that the number of spindles per horse-power in the latter case will be lower. This is due to the fact that the individual or group motors have each the proper horse-power capacity to do its immediate work, while the engine gives only the average indicated horse-power. However, if the average electric horse-power is used on the same bases as the average indicated horse-power, it will show a greater number of spindles. The average percentage of the total power required for the various departments covering all classes of the mill may be divided approximately as follows:—

	Per cent.
Pickers	6·0
Carding	16·0
Spinning and spooling	50·0
Weaving, warping and slashing	23·0
Miscellaneous machinery	5·0
Total	100·0

Detailed Requirements.

The Opener Room.—The opener room machinery whether located in the main mill or detached can be driven by individual motors, or, if desired, the openers, waste machines, &c., may be driven in groups from one motor. The size motor required will vary from 5 to 15 h.p., depending on local conditions.

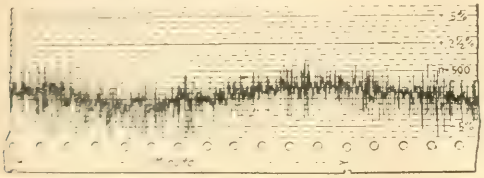


Fig. 4.—Speed Variation on a Spinning Room Line Shaft.

The Picker Room.—The pickers can be driven by individual motors mounted on the [illegible] frame and belted to the beater shaft. These motors will range from 5 to 10 h.p., depending on the beater speed and other conditions. If individual drive is not desired, the pickers may be operated by one or two groups, which will include fans and condenser equipment.

Carding Department.—The general practice is to sub-divide the carding department into small groups using from 20 to 50 h.p. motors. In this department individual motor drive can also be [illegible] drive for the drawing frames, slubbers, speeders and fine frames. Then, too, the roving frames may be driven by two or four frame slow speed motors from 5 to 15 h.p., depending on conditions. The expression "two or four frame" means one motor to two or four frames, the motor being mounted on the ceiling directly over the frames and the motor shaft extended [illegible] with two or four pulleys which require only one belt for each frame.

The Spinning Room.—There is [illegible] department in the mill where the variation in power requirements is so great. This is [illegible] numbers are spun, and whether it is warp or filling, but also to [illegible]

[illegible]

The new bands required 30 per cent. more power to operate than the old bands, but after running for half an hour required only 13 per cent. more than the old bands under normal working conditions.

Another factor entering into the power consumption of the spinning frame is the spindle speed. Actual tests on ring spinning show that as the spindle speed increases the power required is greater. The power increase is not directly proportional to the increase in spindle speed, but is somewhat larger. These tests also show that with an increase of 10 per cent. in spindle speed the power was increased 16 per cent. No set constant can be used for determining the power required for increased spindle speed, but through 7 to 70 per cent. increase in spindle speed the ratio varies from 1·6 to 2.

In electrifying the spinning room the mill man can adopt about any type of drive his fancy calls for. Five to 10 h.p., individual motors can be geared to spinning or twister frames. Ten to 30 h.p., two or four frame motors can be mounted on the ceiling and group drive may be adopted by mounting the motors on the ceiling, wall or floor. The type and horse-power of these motors depend on the specification of the frame, numbers of spindles, size of yarn spun and numbers of ply and whether run wet or dry on the twisters.

The Weaving Department.—The quality of goods produced by the weaving department depends on a number of factors, one of the most important being the speed, which has a decided effect on the uniformity of the fabric, especially on open mesh. Up to the time of the introduction of electric drive the weaver was not able to obtain uniformity of speed, which is necessary for fine work. This has been due to variable belt traction, line shaft torsion and other causes.

The application of individual or group drives for the loom shed should be given the most intelligent analysis in order that the proper drive may be adopted to produce the most uniform fabric.

Individual motors ranging from ½ to 2 h.p., geared to gear ring and keyed to the loose pulley of the loom, may be adopted. The operator can start these motors by friction as with the old belt method. Light or heavy group drive may also be installed in event the mill man does not think the additional production will warrant the extra investment for individual motors. The spoolers and warpers may also be driven by individual motors, from a small group or from a larger group driving some other department.

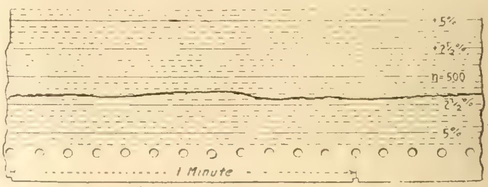


Fig. 5.—The Speed Variation on the Same Shaft With Electric Drive.

Cloth Room and Machine Shop.—Finishing machines can be purchased with individual motors attached, but for the mechanically driven mill changing over to electric drive it has proven more economical and satisfactory to drive the various finishing machines in groups, using a 10 to 25 h.p. motor. The horse power required, however, depends on the capacity of the mill and type of goods manufactured.

In nearly all mechanically driven mills the machine shop is operated by a jack shaft from the main shaft, and when electrified is generally driven in a group by a 5 or 10 h.p. motor. The humidifier pumps [illegible] driven by a 5 to 15 h.p. motor, depending on the size and number of heads.

Slashing and Sizing.—This department is usually driven by one [illegible] the slashers and size kettles being grouped. The power required [illegible] with the number of machines installed and actual [illegible] 5 to 7 beam slashers require from 2·75 to 5 h.p. each. [illegible] used in nearly all cotton mills for some purpose.

[illegible] mill has not the measuring equipment to determine [illegible] the steam requirements for each department; the [illegible] require considerable steam, but it does not, in the [illegible] 20 to 25 per cent. of the total fuel required for [illegible]

[illegible] shown that in a mill operating condensing and using [illegible] approximately 22,000 producing spindles, [illegible] and slashing 15,000 to 20,000 lbs. per [illegible] quantity of steam used for the slashing represented [illegible] of the total steam for power purposes. The estimates [illegible] amount of steam required for this purpose before the [illegible] from 18 to 20 per cent. of the total fuel used.

(To be continued.)

Notes on the Design of Electromagnetic Machines.*

PART III.

DESIGN OF AN ALTERNATING-CURRENT TURBO-GENERATOR.

By STANLEY PARKER SMITH, D.Sc.

(Continued from page 636.)

Summary.—In Part I. of the article the author deals with some of the main principles underlying the design of alternating-current generators. In Part II. these principles are applied to the design of a low-speed, three-phase alternator, giving 750 kw. at 2,200 volts when running at a speed of 250 revs. per min. In Part III. a three-phase turbo-alternator is designed to give 2,000 kw. at 3,000 revs. per min. at a line pressure of 500 volts, and the mechanical stresses in the rotor are discussed.

3. Calculation of the Magnetisation Curve.†

Though it is not possible to settle the dimensions of the magnetic circuit until a rough estimate of the rotor winding and the cooling properties of the machine has been made, in the present instance the particulars given in the drawing in Fig. 18 will be regarded as satisfactory, and the way the several dimensions are arrived at can be explained as we go along.

In axially-ventilated machines only a small part of the cooling air passes along the air gap, so that the length of the gap can be fixed with regard to mechanical considerations and the requirements of pressure regulation. The length of the gap has been fixed at 2 cm.

For cooling the stator there is a large number of axial channels through the stator core, as shown in Fig. 18 B. Behind the slots there are 36 axial ducts, each $2{\cdot}5 \times 2{\cdot}2$ cm., whilst through the core there are 144 round holes of 1·5 cm. diameter arranged in four circles. With six stator segments and 24 holes per segment arranged in this way, successive layers of plates can overlap halfway with the keyways as shown.

Fig. 18 B.—Axial Holes in Stator Core Segment.

For cooling the rotor axial ducts are provided below the wound slots, and empty slots are cut in the pole centres. The empty slots are closed by means of steel wedges to reduce the reluctance of the air gap in this part.

The design of the rotor slotting calls for considerable care and judgment both to prevent excessive throttling of the flux and to find the most economical spread of the winding over the periphery. [illegible]

[illegible] whole pole-pitch [illegible] M.M.F. of the rotor winding [illegible]

[illegible]

practice it is usual to have three to five coils per pole, and if we take 13 slot-pitches per pole, then with five coils per pole $\beta=10/13=0{\cdot}77$; whilst with four poles per coil $\beta=8/13=0{\cdot}62$. Thus by working out these two cases, we can find which value of β is the better.

We shall first calculate the magnetisation curve for the case when $\beta=10/13$, or 13 pitches with 10 wound slots per pole, using the method to pre-determine the open-circuit characteristic which has been described by the author in the Paper just referred to, but extending it to take into account the effects of the stator and rotor leakage and the saturation of the stator and rotor cores.

First we calculate the *air lines* for the wound and unwound parts of the rotor and the *saturation curves* for the stator teeth, rotor teeth and pole-centre, under the assumption that no rotor leakage is present (the stator leakage, of course, only appears in the calculation of the exciting current on load). The magnitude of the rotor leakage is then computed and the saturation curves are correspondingly reduced and added to the respective air lines, thus giving the relation between the flux-density in the gap and the exciting ampere-turns at any position on the rotor periphery. From these resultant magnetisation curves, the flux per pole, and consequently the induced E.M.F., corresponding to any given excitation can be found. Lastly, the effect of the cores is allowed for. Though not essential, it is convenient to carry out the work graphically wherever possible.

The main magnetic circuit of the non-salient pole machine may be divided into the following parts :—

The air-gap.	The rotor pole-centres.
The stator teeth.	The stator core.
The rotor teeth.	The rotor core.

The reluctance of the wound part of the rotor is different from that of the unwound part (or pole-centres) when—as is usual—the latter is either left unslotted or is slotted differently from the wound part. Also the effect of leakage is not the same on the two parts.

(a) *The Air Lines.*—Since about three-fourths of the ampere-turns on no-load are needed by the air-gap, the reluctance of this part of the magnetic circuit must be carefully estimated. The slot-openings and radial ventilating ducts increase the reluctance of the gap by decreasing its effective area, or by increasing its effective length, whichever way we prefer to regard it. The magnitude of this contraction of [illegible] opening, then the effective length of this slot pitch y_s is [illegible]

[illegible]

called the [illegible]

[illegible]

In turbo-alternators and induction motors, however, there may be slots and ducts in both stator and rotor. Now, Carter's results assume there is an equi-potential surface opposite the slot-opening, and when both stator and rotor surfaces are slotted, this equi-potential surface will be somewhere in the gap. Supposing this surface to be known and the gap l_g to be divided by it into the two parts l_1 and l_2, the effective length of the whole gap will be $k_1l_1+k_2l_2$, where the extension coefficients k_1 and k_2 are calculated for the gaps l_1 and l_2 in the usual way. The problem then is to find the position of the equi-potential surface.

Consider the instant when a stator slot is exactly opposite a rotor slot, then if the field around a slot is a function only of the ratio : slot-opening/gap, the position of the equi-potential plane will be such that $l_1 : l_2 = s_1 : s_2$, where s_1 and s_2 are the stator and rotor slot-openings, for in this case the field around a stator slot will be an exact image (to another scale) of the field around a rotor slot. For want of more exact knowledge, we shall assume this also to be the position of the equi-potential surface in the gap for other relative positions of stator and rotor teeth.

that is $$k'_1=\frac{l_g}{l_1}k'_{g1},$$

and similarly $$k'_2=\frac{l_g}{l_2}k'_{g2}.$$

Substituting in the above expression for k_g we then get

$$k_g=1+k'_{g1}+k'_{g2},$$

where we only need to calculate the extension coefficients for the whole gap.

When there are radial ventilating ducts also we then have :

$$k_g=(1+k'_{g1}+k'_{g2})(1+k'_{g3}+k'_{g4}),$$

where $1+k'_{g1}+k'_{g2}$ is for the slot-openings, and $1+k'_{g3}+k'_{g4}$ is for the duct-openings.

This very simple method of dealing with two slotted surfaces was suggested by Mr. Neville, who found that the above expression is also true when all the stator slots are midway between the rotor slots.

Applying this correction to the present design, we have for the stator slots :—

$$\frac{\text{opening}}{\text{gap}}=\frac{0{\cdot}8}{2{\cdot}0}=0{\cdot}4\,;\quad y=0{\cdot}07\,;\quad k_{g1}=\frac{5{\cdot}67}{5{\cdot}67-0{\cdot}07\times0{\cdot}8}=1{\cdot}01,$$

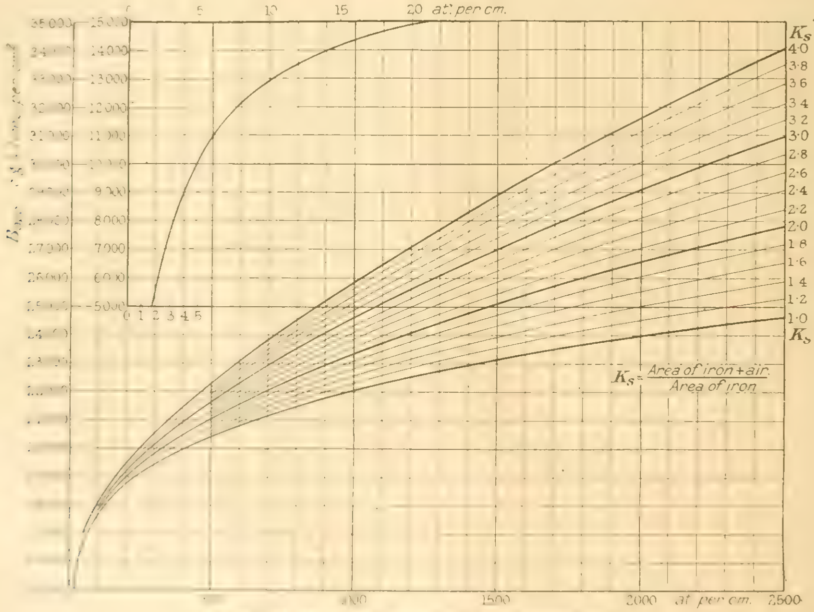


FIG. 19.—MAGNETISATION CURVES FOR TURBO-ROTOR STEEL.

[illegible]

and for the rotor slots :

$$\frac{\text{opening}}{\text{gap}}=\frac{2{\cdot}8}{2{\cdot}0}=1{\cdot}4\,;\quad y=0{\cdot}21\,;\quad k_{g2}=\frac{7{\cdot}36}{7{\cdot}36-0{\cdot}21\times2{\cdot}8}=1{\cdot}087.$$

Thus $k'_{g1}=k_{g1}-1=0{\cdot}01$ and $k'_{g2}=k_{g2}-1=0{\cdot}087$.

There are no radial ducts in this machine, the mode of ventilation being purely axial. Further, the rotor slots in the centre of the rotor poles are closed by steel wedges, making the rotor slot-opening zero over this part, hence we get the following values for the extension coefficients :—

For the *wound* part of rotor :

$$k'_g=1+k'_{g1}+k'_{g2}=1+0{\cdot}01+0{\cdot}087=1{\cdot}1.$$

For the *unwound* part of rotor :

$$k''_g=1+k'_{g1}=1{\cdot}01$$

The effective length of the air gap will then be :—

For the *wound* part of rotor :

$$l'=k'_gl_g=1{\cdot}1\times2{\cdot}0=2{\cdot}2\text{ cm.}$$

For the *unwound* part of rotor :

$$l''=k''_gl_g=1{\cdot}01\times2{\cdot}0=2{\cdot}02\text{ cm.}$$

Taking $B_g=10{,}000$ as a convenient value, we have then for the ampere-turns per pole :—

For the *wound* part of rotor :—

$$AT'_g=\frac{1}{0{\cdot}4\pi}B_g l'_g=7{\cdot}960\times 2{\cdot}2=17{,}500.$$

For the *unwound* part of rotor :

$$AT''_g=\frac{1}{0{\cdot}4\pi}B_g l''_g=7{\cdot}960\times 2{\cdot}02=16{,}100.$$

The air lines can now be plotted, and are shown in Fig. 23A, curve (1) being for the region of the pole-centres, and curve (2) for the remainder of the rotor periphery.

In settling the scales for these curves, it is usually enough to make $B_g=10{,}000$, and the maximum ampere-turns per pole $1\frac{1}{2}$ times the maximum value needed for the air lines.

(*b*) *The Saturation Curves.*—These curves are calculated under the assumption that the whole of the flux passes radially through the rotor teeth, air-gap and stator teeth, the correction for rotor leakage being made later. For the area of the iron paths, any convenient sector can be considered, *e.g.*, a slot-pitch, a pole-pitch, or the whole circumference. A convenient sector is one slot-pitch, and we shall assume this in all the following calculations.

Let A_g denote the actual gap area over the whole periphery at the centre of the air-gap, and S the number of slot-pitches in the rotor or stator periphery as the case may be, then A_g/S denotes the gap area corresponding to one slot-pitch. Let A_x denote the iron area at any section x in the tooth considered, and B_x the apparent flux-density in the iron at this section, that is, the density assuming no flux passes up the slots or ducts, then for a density B_g in the gap, we have

$$B_x A_x=B_g\frac{A_g}{S},$$

hence the *apparent* flux-density in the iron will be

$$B_x=\frac{B_g(A_g/S)}{A_x}.$$

The *area of the gap* A_g is calculated at the centre of the gap, so that $A_g=\pi(D-l_g)L_g$, where L_g is taken somewhat larger than the core-length L, to allow for fringing at the ends. This correction, however, is small, since skin effects prevent flux entering the stator cast iron end plates, and a sufficient allowance will be made if we take $L_g=L+l_g$ (*i.e.*, core length + gap length), whence we have $A_g=\pi(65-2)(100+2)=20{,}200$ cm.²

The *core area* A_x is simply the product of the iron length and tooth width at the section [illegible] where [illegible] and [illegible] denote the slot-pitch and slot width respectively at the section considered.

For the unwound part of the pole the section is taken between the centre lines of the two neighbouring wound slots.

[illegible]

$$K_s=\frac{\text{total area}}{\text{iron area}}=\frac{A_x+A_s}{A_x}=\frac{l_s}{L_i b_x}\ [illegible]$$

[illegible] The flux Φ passing through any section is :

$$\Phi=A_x H+A_x B_i$$

so that the apparent flux-density B_x in the iron is

$$B_x=\frac{\Phi}{A_x}=\frac{A_s}{A_x}H+B_i=\frac{A_s}{A_x}H+(H+4\pi\mathfrak{J})$$

$$=\frac{A_x+A_s}{A_x}H+4\pi\mathfrak{J}=K_s H+4\pi\mathfrak{J}$$

where $\mathfrak{J}$ is the intensity of magnetisation.

From the B-H curve for the steel used, we find the curve $B=f(4\pi\mathfrak{J})$ straightaway, and then by giving K_s suitable values, we obtain a series of curves like that shown in Fig. 19. Such a set of curves must be drawn, of course, for each particular brand of stamping or forging used, and is essential for the high densities met with in these machines. The curves shown in Fig. 19 for turbo-rotor steel have been obtained in this way from the B-H curve marked $K_s=1{\cdot}0$. In passing, it may be mentioned that this curve does not represent a particular grade of steel, but has been constructed from data obtained from various sources. Failing more accurate information, the curves in Fig. 19 can be used for the high-grade steel used in modern practice for solid turbo-rotors.

(i.) *The Stator Teeth.*—The stator teeth are sometimes of rather complex shape, due to the presence of an axial duct above or below the slot copper. On account of heating, the flux-density in the teeth of 50-cycle machines is seldom high ; consequently only few ampere-turns are needed for this part of the magnetic path—about 1 per cent. of the total excitation

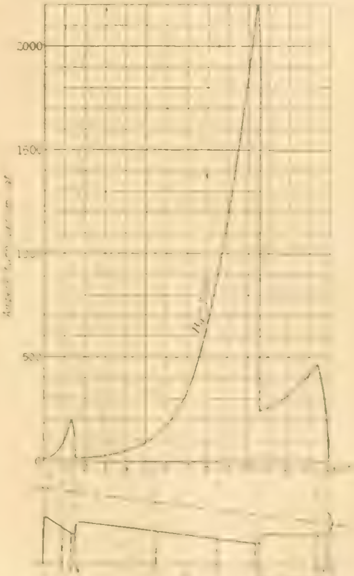


FIG. 20.—[illegible] METHOD OF FINDING MEAN VALUE OF AMPERE-TURNS PER CM. FOR [illegible] TEETH.

—so that a simple, approximate method can be used. In [illegible] densities and corresponding values of the ampere-turns [illegible] values lie nearly on a parabolic curve. Thus

[illegible]

[illegible]

[illegible] The

[illegible]

the width varies between wide limits, and the densities reach the most extreme values.

Actually, of course, these calculations are made in tabular form, all the above items appearing along a horizontal line in their respective columns; but the above outline shows clearly how the magnetisation curves are obtained.

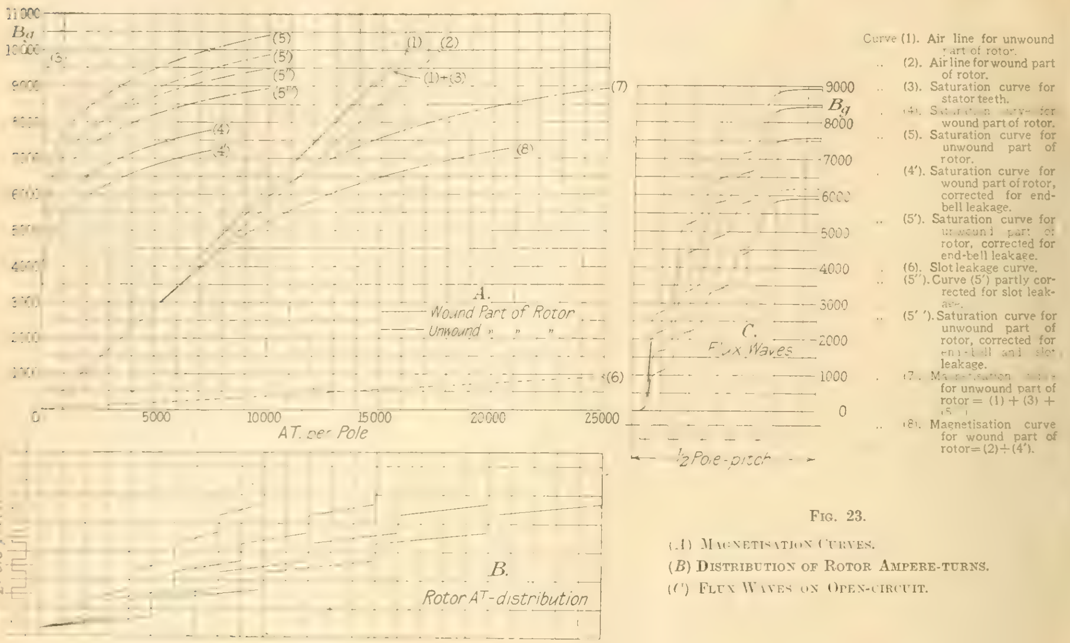


FIG. 23.

(A) MAGNETISATION CURVES.
(B) DISTRIBUTION OF ROTOR AMPERE-TURNS.
(C) FLUX WAVES ON OPEN-CIRCUIT.

To find the ampere-turns for the rotor teeth the wedge, slot and duct portions can be dealt with separately, the mean value of at for each part being found by aid of Simpson's rule. Whenever B_x exceeds 18,000, correction must be made for the flux in air by calculating K_s and using the curves in Fig. 19.*

When graphical aids are used—as in the present case—sections must be taken where the flux-density undergoes rapid change and at other suitable places. The several values of at are then plotted with the tooth as base, as shown in Fig. 20 (drawn for $B_g = 7{,}500$), and the area of the curve measured by means of a planimeter, whence the mean value of at is found.

The points thus calculated for B_g = 4,000, 5,500, 6,500 and 7,500 are shown plotted in Fig. 23A, giving the curve (4) for the wound part of the rotor.

As an illustration of the method of calculating the value of [illegible]

[illegible]

(iii.) *The Rotor Pole-centres.*—The unwound part of the rotor of this machine is slotted for purposes of ventilation, but the slots are made smaller than the wound slots and are rounded at the bottom to reduce reluctance. Since the three slots in the pole-centre are closed by steel wedges, the whole of the unwound part is treated as one wide tooth, having a pitch equal to four rotor slot-pitches—that is, to the distance between the centre of the neighbouring wound slots. The presence of the different slots in this part make it needful to take more sections than when it is unslotted; indeed, in the latter case, it is often enough to take five sections and apply Simpson's rule to find the mean ampere-turns per cm. It will be noticed that in accordance with the foregoing there are $S = 26/4$ pole-centre pitches, so that the gap area over a single pitch = A/S = 20,200 × 4/26 = 3,100 cm.². The mean gap densities B_g are taken as 6,000, 8,000, 9,000 and 10,000. As for the rotor teeth, so here, we can find the mean value of at graphically. The pole-centre saturation curve is plotted as (5) in Fig. 23A.

(*To be continued.*)

Sphere-Gaps for Lightning Arresters.*

By A. B. GOODWIN.

[illegible]

* [illegible]

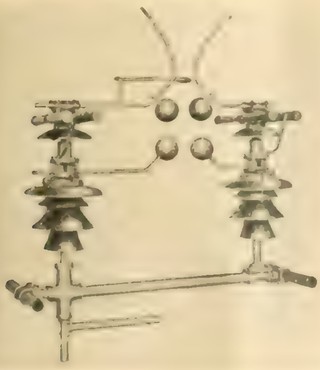
Since the lag decreases very rapidly with an increase in the rate of application of potential it is evident that it becomes a very important factor when dealing with lightning or other abnormal potentials which have steep wave-fronts.

Investigations of lightning troubles in stations frequently reveal apparent inconsistencies. Arcs have taken place across spaces which are much greater than others on the same circuit, all being apparently subjected to the same voltage. Many of these peculiar failures can be explained by giving proper consideration to this property of dielectric spark-lag.

Let us assume, for example, that we have two or more pieces of insulation in parallel, such as air, oil, or porcelain, and that they have different lags due to variations in the factors just mentioned. If now, we instantly apply a voltage much above the value required to rupture the best test piece, they will break down in succession according to their individual time-lags. This assumes that the abnormal voltage is sustained until the lag of the slowest part is exceeded. In actual practice this seldom occurs, since the breaking down of the first one short circuits the abnormal voltage, and sometimes the normal voltage, and prevents further breakdowns. In this case the insulation having the shortest lag breaks down, thus protecting the others.

In the original Paper this phenomenon of variation of spark-lag is demonstrated by a series of tests on different circuits comprising horns and gaps of various kinds. The spark of needles, horn and sphere gaps are thus readily compared.

Applying the ideas developed these tests to the protection of apparatus. There are two natural conclusions: first, the time-lag of the insulation of the apparatus should be made as great as possible;



second, the time-lag of the protective devices should be made as small as possible. In other words, the insulation of the apparatus should be designed to be as slow as practicable, and the lightning arrester should be made as fast as possible. [illegible]

[illegible]

[illegible]

Railway Electrification in the U.S.A.

The Chicago, Milwaukee & St. Paul Railway Co. recently placed orders for the sub-station equipment of 217 route-miles of line (the Othello, Seattle and Tacoma division), and also for 17 locomotives. The Westinghouse Company has secured orders for 10 locomotives and three sub-stations, while the General Electric Co. will supply seven locomotives and the equipment for five sub-stations. At each sub-station there will be one or more 2,000 kw. motor-generator sets and corresponding high-tension apparatus. The passenger locomotives are guaranteed to haul 12 all-steel cars at 25 miles per hour on a 2 per cent. gradient. The route mileage of road already electrified is 437·6, and with the section in course of conversion the total will be 654·5 route-miles. The location of the sub-stations, number of units and mileage between stations are as under :—

Sub-station.	No. of 2,000 kw. motor-generator sets.	Mileage between stations.
Tacoma Junction	2	
Renton	1 (room for 2)	28·7
Cedar Falls (foot of 20 mile, 1·7 per cent. grade)	2 (room for 3)	27·2
Hyak (other side of grade)	2 (room for 3)	21·7
Cle Elum	1 (room for 2)	29·0
Kittitas	2 (room for 3)	31·6
Dorston (2·2 per cent. grade)	2 (room for 3)	23·0
Taunton (end of line)	2	34·9

The 3,000-volt direct-current motor-generator sets to be supplied will be similar to those previously furnished by the General Electric Co., namely, the combination of a 2,500 k.v.a., 2,300-volt 60-cycle motor and two 1,000 kw. 1,500-volt direct-current generators connected in series. These sets will carry three times their rated load—i.e., 200 per cent. overload—for five minutes. The efficiencies of the General Electric sets are to be: at 50 per cent. overload, 92·6 per cent.; at full load, 92·4 per cent.; at one-half load, 88·8 per cent. The Westinghouse sets will be substantially the same in regard to capacity and efficiency. At Tacoma and Renton, 55,000-volt power covering about one-third of the requirements will be received from Stone & Webster plants, while the remainder, at 102,000 volts, will come from the Washington Water Power Co. There will be installed one 2,500 k.v.a. transformer for every 2,000 kw. motor-generator set.

LOCOMOTIVES.

Of the seven locomotives ordered from the General Electric Co., two are switching locomotives of the ... type. [illegible]

[illegible]

[illegible]

The Electrician.
FRIDAY, FEBRUARY 8th, 1918.
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Telephone: City 9853 (4 lines). Telegrams: "Benbrotric Fleet London."

Economy in Effort.

In theory it is generally agreed that our manufacturers will not be able to spend their time in unnecessary effort if the industrial position of this country is to be maintained in competition with other countries. In other words, there should be economy so as to secure the greatest production for a given effort; that is, to secure the greatest commercial return under working conditions. We doubt, however, if sufficient attention is being paid to the subject and to the importance of eliminating from manufacture all sizes of plant which are not really necessary. Such elimination should be taken in hand at the present time, and not left to look after itself in the future. This is especially a subject which should be taken up by our manufacturers' associations, such as the Federation of British Industries and the British Electrical and Allied Manufacturers' Association in consultation with the large consumers, such as electricity supply authorities. We do not suggest that nothing is being done in this direction, but we feel that events are not moving with sufficient rapidity. The movement so far has too much of an optional character.

On the ground that this subject has not yet been sufficiently considered in this country it is consoling to know that standardisation in Germany has not reached the advanced stage that might have been expected. This is emphasised by an article which appeared last year in the "Elektrotechnische Zeitschrift," by Mr. G. STERN. The author points out that although there has been a fair amount of standardisation in regard to machines of medium sizes, there are still voltages of 110, 220 and 440, and on polyphase circuits there are pressures of 190 and 380 volts, in addition to various speeds and frequencies. Thus many combinations are possible. The most unsatisfactory position, however, appears to be in connection with transformers. So far, nothing has been done to standardise the windings of transformers, and thus considerable confusion occurs. Nominally the position is not so bad, for there are stations which officially have only one high and one low pressure; but their orders show every conceivable variation from these pressures, and thus a multitude of special windings are required. It is also often stipulated that a transformer is to be capable of being used on either of two high pressures, in the ratio of one to two. Taking the position generally, it appears that there are 62 high pressures and 35 low pressures in use in Germany, while there are 245 ratios of transformation. A case is mentioned of a central station in the West of Germany which has nominally only two high and [illegible] low pressures, yet the books of the A.E.G. show that orders have been received from the station involving 20 different ratios of transformation. Another large station, near Berlin, has nominally one high and three low pressures. This should require three ratios of transformation, yet orders have been received for 30 ratios of transformation, along with certain prescribed methods of connection. The author arrives at the conclusion that there are not merely 245 ratios of transformation at present in use in Germany, but approximately 2000; and he contrasts this state of affairs with that existing in the United States, where there are two ordinary high pressures, namely, [illegible] and [illegible], and two low pressures, namely, 110 and 220 volts; also there are only two frequencies, namely, 25 and 60, for each of which there is a standard winding.

It must be remembered that although we are allied with the United States at the present time in military efforts, we are not allied in manufacturing efforts; and that we shall undoubtedly, and of necessity, be in competition with the United States in our engineering industries immediately after the war. We cannot afford, therefore, to neglect these matters. We are glad to see that the position is appreciated in South Africa, where the war has shown the serious objection to having a great variety of plant when there is difficulty in replenishing stocks. At the recent convention of the Association of Municipal Electrical Engineers (of South Africa) the standardisation of South African electricity supply systems was discussed in a Paper by Mr. JOHN ROBERTS. He touched on many points on which definite conclusions could not be reached; but, as a beginning, certain standards were agreed. Thus it was decided that the standard current should be alternating, three-phase, and that the frequency should be 50 periods. Generating pressures are to be 415, 3,300 and 6,600 volts. Supply pressures are to be 240 and 480 for three-wire, and 240 and 415 A.C. four-wire. Systems of distribution are to be on the four-wire three-phase system, and transmission pressures are to be 3,300, 6,600 and 11,000 volts. Certain recommendations were also made in regard to bare conductors for overhead wires, underground mains, meters, and plugs for heating and other circuits. We hope that before long similar action may be taken in this country, so that the burden on our manufacturers may be as light as possible, and the manufacturing output may be a maximum for a given effort.

Review.

Telegraph Practice. By JOHN LEE, M.A. (London: Longmans Green & Co.) Pp. ix. + 102. 2s. 6d. net.

This book is written in order to outline the fundamentals of telegraph practice in such a way as to indicate differences in method as adopted by different administrations. In an introductory chapter the author analyses the various factors determining the British system, which, he says, is not a mere growth adapting itself to circumstances with that reluctance to change commonly ascribed to Government departments, but the result of long and minute discussions and the detailed consideration of comparative methods.

Then follows a plain statement of the various problems involved in the various stages in the progress of a telegram from acceptance to delivery. Broadly speaking, to deal with 80 telegrams of ordinary difficulty in an hour is good work, but with abnormal conditions (race meetings, stock exchanges, &c.), higher figures may be recorded.

Subsequently such matters as the centralisation of telegraph practice, telegraph instrument rooms and instruments, and the whole telegraph organism are discussed, and chapters are devoted to Press telegrams and tariffs. In regard to Press telegrams an important point in the British system is the entire dissociation of the functions of conveying and collecting news; the latter cannot be undertaken by a Government Department, and hence is effected by various agencies. English freedom of expression of opinion is, in the author's opinion, largely attributable to the cheap tariff for news, which compares favourably with that of every other country.

In a final chapter on the Future of Telegraph Practice, the author refers to the influence of considerations of military communications on which important experience has been acquired. The tendency generally is towards greater simplification, and there are several directions in which the influence of practice in the United States is making itself felt.

The Standardisation of Transformers.*

By G. STERN.

The standardisation of marketable wares seems so obviously desirable that any discussion of the subject would appear to be a waste of breath. Cheapness, quick delivery, universal adaptability seem most easily attainable under a system of standardised products. The gas and water installations, the girder industry, and all the many activities depending on the installation of electric lighting, are all so many instances in which standardisation is essential. Thus, the sizes of lamp sockets, wall plugs, fuses, &c., can in no cases be arbitrarily chosen. At the same time, standardisation denotes a certain bar to the activity of free development, and it is undesirable before a certain state of progress has been reached; it is also beset with difficulties if it is attempted too late, when individualistic competition has produced too many varieties to be easily compressed within one normal standard.

In the province of the manufacture of electrical generators there is a fair amount of standardisation with regard to machines of medium size. There are voltages of 110, 220 and 440; on polyphase circuits there are also the common pressures of 190 and 380 volts. These, taken in conjunction with the common speeds and frequencies, make the work of the manufacturers of motors easy. The object of the present lines is to draw attention to the desirability of considering the case of the transformer. Something has already been done. Every firm has certain types or models, and the construction of the interior generally proceeds on certain fixed lines. The complete transformer is, in fact, the product of certain standard parts and arrangements. Also the outputs proceed by certain graded levels, about which there is a kind of tacit consent, though much more might be done. But nothing can be done to standardise the winding of transformers so long as the present incredible chaos continues in the matter of pressures.

The standardisation of transformers requires the consideration of the following points, viz.: (1) Frequency; (2) the nature of the current, polyphase or single phase; (3) output; (4) capacity for overload; (5) methods of connection; (6) primary pressure; (7) secondary pressure; (8) tappings; and (9) the magnitude of the short-circuit voltage. As for frequency, in Germany this may be said to be settled, and the few installations that have any periodicity but 50 must disappear. Also the three-phase installations are vastly the most important. The single-phase installations in Germany are not sufficiently numerous to make it necessary to worry about the standardisation of single-phase transformers. The two-phase installations are doomed to a not far distant death. The methods of connection are very varying in any given group. If the question of running in parallel were all important, something could be done; but this is not always the case with transformers of small and medium size. Undoubtedly the most difficult point is the matter of pressure. The standardisation of secondary pressures ought to meet with no insuperable difficulties. Motors and lamps seem capable of being standardised for all pressures. And it ought not to be difficult with the secondary pressures for transformers, if allowance is made for certain percentage variations by means of tappings. It is much more difficult to deal with normal primary pressures for transformers of medium size, for it is not so much a question of dealing with new networks as of extending the old ones.

The present state of affairs in Germany can be seen at a glance if one consults the official returns, which are, however, not drawn up with the intention of [illegible] transformer pressures. [illegible]

connection are prescribed. One can therefore assume that there are not 245 ratios of transformation at present in use in Germany, but approximately 2,000. It is rather late in the day to try to restore order to this chaotic condition of things. The methods of connection cannot be seen at a glance from the statistics, and, of course, this introduces more confusion, as the method of connection controls the method of winding, if a given output is presupposed.

If one examines this mad go-as-you-please system, one can only admire the wonderful simplicity of the methods of the United States. For single-phase transformers there are two ordinary high pressures—viz., 1,040 and 2,080 volts—and two low pressures, 110 and 220 volts. The outputs are also standardised. There are two ordinary periodicities—viz., 25 and 60; for each of these there is a standardised winding, which can be used on secondary and primary pressures which are in the ratio of 1 to 2. The result is that in an American factory the stores are well filled with marketable products, a sight which brings joy to the manufacturer and consumer alike. The central station engineer would presumably be better pleased if he could obtain what he wants more cheaply from the maker's stores than if he had to wait while a special transformer was made to his order at great cost; but then he must give up his peculiar notions of a secondary pressure of 225, 226 or 221, and must content himself once for all with 230. The manufacturer would have his advantage by being able to make in bulk. At the author's suggestion, Herr Korndörfer has worked out certain proposals for the standardisation of transformers which are here given, as they appear to constitute a basis on which argument and discussion can profitably be started.

Let us take three different windings for the limb of a transformer, each consisting of two equal coils. If the coils are joined in parallel, and the transformers are connected in star fashion, then the windings may be supposed to be suitable for 115, 125 and 230 volts. Then, if the coils are joined in series and the transformers connected in star fashion, [illegible] 230, 250 and 460 volts. If the transformers are connected zig-zag, then we get pressures of $115\sqrt{3}$, $125\sqrt{3}$ and $230\sqrt{3}$—*i.e.*, 199, 216 and 398 volts. With primaries, let us have pressures of 2,000, 3,000, 5,000, 6,000, 10,000 and 15,000 volts, each with tappings allowing a variation of 3 per cent. on either side of the mean. The short-circuit pressures should be 2·5 to 3 per cent. The outputs should be 5, 10, 20, 30 and 50 k.v.a.; this leaves outputs of 1, 2, 3, 7·5, 15, 25 and 40 k.v.a., which have hitherto been usual; but it simplifies the discussion. It may be remarked that the delta method of connections is intentionally excluded. It is known generally that with transformers of small and medium sizes the delta method can in almost all cases be replaced by the zig-zag method. The delta method on the high-pressure side is generally required if the neutral point is to be loaded on the low-pressure side; but the zig-zag method does this equally well. Only when a parallel connection is to be run to an already existing transformer which has delta connections on both sides or delta connections on the primary and inverted delta on the secondary, and when the new transformer is to have a loaded neutral point—only in this unusual case the new transformer must have delta connections on the high-pressure side; but a case of this kind can generally be avoided in practice. In any [illegible]

[illegible]

* Abstracted from the [illegible]

The Measurement of Small Inductances and on Power Losses in Condensers.*

By ALBERT CAMPBELL, B.A.

The measurement of very small self-inductances of circuits having only two terminals is a matter of no great difficulty, if the resistances are not high.

One of the simplest ways of doing this is by Heaviside's method,† in which comparison is made with a known mutual inductance.

It is easy to build a mutual inductometer of almost any desired lowness of range by using the device of stranding the windings of the coils. The lowest range of the instrument used in the measurements here described was from 0 to 1 microhenry, the scale being readable to 0·001 microhenry at the upper part. An instrument of this kind combined with a constant inductance rheostat (and ratio arm coils) is sufficient for dealing with two-terminal resistances. This bridge system is not directly applicable to four-terminal resistances, in which the potential terminals are distinct from the other two, but Venner ‡ has shown that the inductances of such resistances can be determined by the addition of the Kelvin double bridge device to the Heaviside bridge.

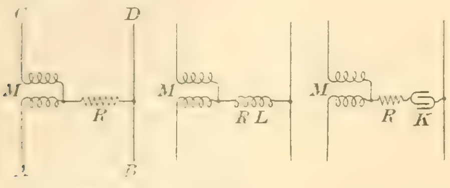

FIG. 1. FIG. 2. FIG. 3.

Methods Using M, R Element.—The methods to be described are simple in their working, requiring only a single-phase source of current; on the other hand, they have certain limitations in practice. They are developments of the method of testing transformers which I described some years ago.§ The fundamental principle in that method was the introduction of the elementary pair (M, R) shown in Fig. 1, where A B are current terminals and C D potential points (or *vice versa*).

Other methods of utilising this element have been developed by [illegible].

The elementary pair (M, R) may be further developed by associating with R either self-inductance or capacity as in Figs. 2 and 3. These two cases require the same mathematical treatment, but they have different applications in practice.

I shall first discuss the case of self-inductance.

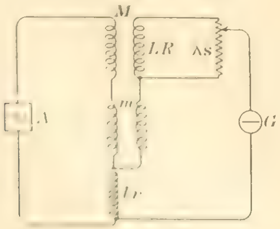

FIG. 4.

Method 1.—In Fig. 4 let r be a resistance with potential terminals, [illegible]

[illegible]

[illegible]

Now, let L/R be (relatively) large, and λ/S small and λM negligible compared with $L\ (l+m)$; then the above equation becomes

$$L(l+m)\omega^2 = r(R+S),$$

which gives l conveniently without requiring an exact knowledge of M and λ.

A disadvantage of this method is that usually the proper conditions are not easily obtained unless the frequency is tolerably high (say, 800 ∿ per second). It should be noted, however, that the resistance and self-inductance of a properly designed shunt remain practically constant up to such frequencies.

Example.—The shunt to be tested had a resistance $r=0{\cdot}01$ ohm. With $R+S=5{\cdot}99$ ohms, $S=0{\cdot}274$ ohm, $L=0{\cdot}0100$ henry, λ less than 1 μ henry, $M=370$ μ henries, a balance was obtained when m was 0·177 μ henry, the frequency n being 800 ∿ per second. Hence, from the equation above, $l=0{\cdot}063\,\mu$ henry. The current used was of the order of 0·1 ampere, and was obtained from a small buzzer.

Method 2.—A method more generally applicable is shown in Fig. 5, r being the resistance whose self-inductance l is to be determined, and m a low-reading inductometer. The primary circuit is also linked to the galvanometer circuit by an intermediary closed circuit having resistance R and self-inductance L. The linking mutual inductances should be variable, but in general need not be known. There should be no direct mutual inductance between the primary circuit and the galvanometer circuit other than m. This condition can always be checked by opening the intermediary (L, R) circuit; then, when r is cut out m should read zero. The best plan is to put the four coils forming M_1 and M_2 at a good distance from the m inductometer, and to turn them so as to be conjugate to each other pair and to the inductometer coils.

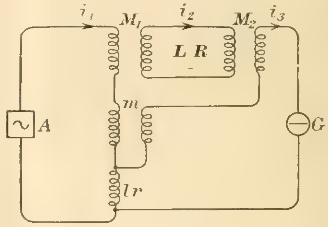

FIG. 5.

Let the instantaneous values of the currents in the three circuits be i_1, i_2 and i_3 as shown; and let $a=\omega\sqrt{-1}$.

It is then shown by the author, in the original Paper, that

$$r = \frac{RM_1M_2\omega^2}{R^2+L^2\omega^2} = \frac{M_1M_2\omega^2}{R},$$

when $L\omega/R$ is small,

and that
$$m-l = \frac{LM_1M_2\omega^2}{R^2+L^2\omega^2} = \frac{LN_1M_2\omega^2}{R^2},$$

where $L\omega/R$ is small.

The following two examples show the relative magnitudes of the quantities involved for two different frequencies:—

r ohm.	l henry.	n ∿ per sec.	m/l.	R ohms.	Microhenries. L	M_1	M_2
0·01	0·05	100	2	10	50	250	1000
0·01	0·05	800	2	50	250	200	100

$(m-l)$ must always be positive, and since

$$Rr = [M_1M_2 - L^2r/R]\omega^2,$$

M_1M_1 must always be greater than L^2r/R.

Current Transformer Compensated for Frequency.—The elementary pair (M, R) of Fig. 1 is of interest in connection with current transformers. In an ironless transformer let M be the mutual inductance and let Q and L be the resistance and self-inductance of the secondary circuit. Then, if I_1 and I_2 are the effective values of the primary and secondary currents, it is well known that

$$\frac{I_1^2}{I_2^2} = \frac{Q^2+L^2\omega^2}{M^2\omega^2},$$

[illegible] the current transformation ratio is not constant for different frequencies.

[illegible]

Now let a resistance R be inserted as shown in Fig. 6. Then we have

$$\frac{I_1^2}{I_2^2} = \frac{(R+Q)^2 + L^2\omega^2}{R^2+M^2\omega^2}.$$

The ratio is independent of ω and equal to L/M, if

$$(R+Q)/R = L/M.$$

When this condition is satisfied the ratio of current transformation will be constant for all frequencies, and hence also for all wave forms.

DETERMINATION OF CAPACITY IN TERMS OF MUTUAL INDUCTANCE AND FREQUENCY.

In a former communication * I described a very simple method for quick and accurate determinations of frequency by the help of a known condenser and a variable mutual inductance.

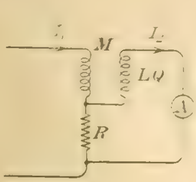

FIG. 6.

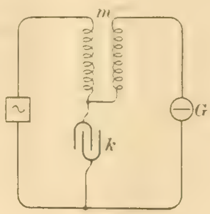

FIG. 7.

With the method in its simplest form, as shown in Fig. 7, the mutual inductance m is adjusted until G, the vibration galvanometer (or telephone) shows no current. Then, $mk\omega^2 = 1$.

But unless the condenser is free from leakage (or other power loss), a perfect balance cannot be obtained, but only a minimum current in the detecting instrument. With an imperfect condenser, however, this trouble can be entirely eliminated by adding an auxiliary closed circuit similar to that in Fig. 5. By this device the condenser losses can always be compensated for and a perfect balance obtained. The complete method is shown in Fig. 8, in which the imperfection of the condenser is represented by the series resistance r.

Let the current in G be reduced to zero by adjusting m and M_1 or M_2.

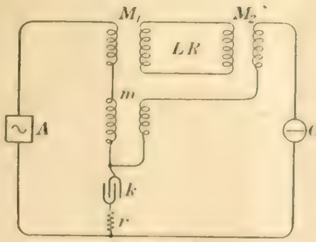

FIG. 8.

The conditions for balance are obtained when

$$1/k\omega^2 = m + rL/R, \text{ and } R^2 = \{M_1M_2 + (m - 1/k\omega^2)L\}\omega^2.$$

Hence $\qquad R^2 = (M_1M_2 - Lr/R)\omega^2.$

Here also M_1M_2 must be greater than Lr/R, except in the limiting case of a perfect condenser, where $r = 0$ and then M_1M_2 also $= 0$.

When ω is known, we can obtain k and r and hence $rk\omega$, the power factor of the condenser.

When the method is used for measuring frequency, it is best to arrange the auxiliary closed circuit so that L/R is very small, and hence rL/R negligible compared with m. Then $\omega^2 = 1/km$, and the frequency is determined as though the condenser were perfect.

In general the auxiliary closed circuit can be a few turns of wire mounted so as to be movable close to the coils of the inductometer giving m. Sometimes even a [illegible] about [illegible] the coils is sufficient to make the balance [illegible]. With a given condenser the scale of the inductometer can be graduated to read the frequency directly, and with a suitable set of condensers the same scale may be used with even multiples.

* Proc. Phys. Soc., vol. 21, and Phil. Mag., p. 1[illegible], 1908.

When the wave form of the source of current contains strong harmonics these may somewhat obscure the point of balance when a telephone is used as the detecting instrument. For frequencies from 200 up to 5,000 ∿ per second, the harmonics cause very little trouble if the primary self-inductance in the inductometer is kept relatively high.

In a former communication * I have described the use of the condenser and mutual inductance combination as a wave sifter by which a component of any desired frequency can be suppressed in a given circuit. The addition of the auxiliary closed circuit here described makes the sifting perfect even when quite common paraffin paper condensers are used.

When the power loss in the condenser (and hence its power factor) is to be determined, usually it is best to keep L/R very small.

Then $\qquad r \doteq M_1M_2\omega^2/R.$

In this case L need not be known accurately, but M_1M_2 must be determined. The same care must be taken with regard to the position of the coils forming M_1 and M_2 as in Method 2. Or M_1M_2 may be directly determined by adding a known resistance s to the condenser circuit and altering R to R' to obtain a rebalance.

Then $\qquad M_1M_2\omega^2 = s/(1/R' - 1/R).$

In this case the loop (L, R) may be placed over the inductometer coils if desired.

The following example gives an idea of the relative values of the various inductances and resistances in the determination of the power factor of a good quality mica condenser of capacitance 0·1 μF and power factor 0·0005 using a frequency of 800 ∿ per second. Here $\omega = 5{,}000$, $m = 0{\cdot}4$ henry, and $r = 1$ ohm. If $R = 10$ ohms, then $M_1M_2 = 4 \times 10^{-6}$, and M_1 and M_2 can be 2 millihenries each.

It should be remarked, however, that, although this method of determining the power factor of a condenser may be a good one for certain cases, for general use the Carey Foster method appears to hold the highest place for simplicity and accuracy.

If the source gives damped oscillations of the form $\epsilon^{-bt}\cos\omega t$, where $b = n \times$ log. decrement, then (Fig. 7) it is easy to show that, for a balance,

$$mk(\omega^2 + b^2) = 1 \text{ and } 2mb = r,$$

where r is the series resistance including that which represents the loss in the condenser. Here no auxiliary circuit is required to balance the loss, if by external addition r can be made to satisfy the last equation.

Electric Setting of Points With Optical Indicators.†

The Munich tramway system is provided with 65 track junctions operated electrically from the cars. During darkness the position of the points is indicated to the driver by electrically illuminated

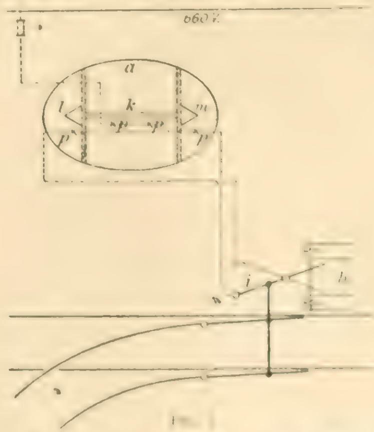

FIG. [illegible]

indicators. These indicators are of the [illegible] type shown in Fig. 2, and the [illegible]

* Proc. Phys. Soc., [illegible], 1911.

† Abstract of a paper in the [illegible] Nov. 14, 1917.

the same time as the points are shifted. The original indicator A was not found to be clear enough, especially in misty weather, and it is improved upon by the indicators B and C, in which the shaft according to the position of the tongue-shifter i. The lamps in the shaft k of the arrow are permanently in circuit. The indicator box is divided into three partitions, of which only two are illuminated

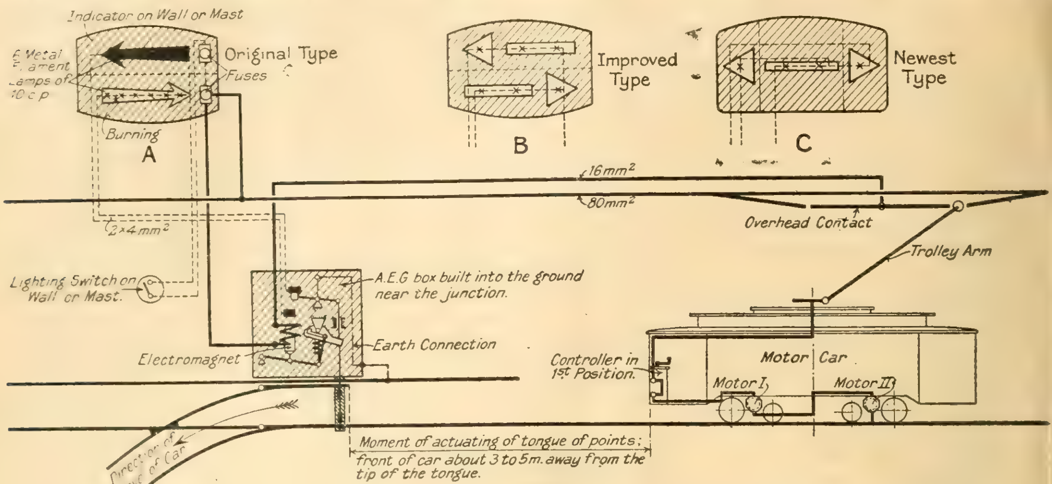

FIG. 2.

of the arrow is separated from the head and the heads are increased in size. The newest indicator is shown in Fig. 1. It has one double-headed arrow, and the lamps l or m are illuminated alternatively at the same time. It will be noted that this indicator uses less lamps, and is, therefore, more economical to run than the original type A.

Standardisation in South African Electric Supply Systems.*

By JOHN ROBERTS.

All those in charge of electric supply undertakings in this country [illegible] must have been struck with the absence of rules or laid [illegible] in all the branches of their work. In such a new [illegible] as electricity supply complete standardisation is not yet [illegible].

But even now the time is ripe for some general agreement in the direction of uniformity in methods and materials between those responsible for the extension of electric science throughout the Union of South Africa.

ADVANTAGES OF STANDARDISATION.

In this country the absence of any standards is even more acutely [illegible] in those countries where plant is manufactured, because [illegible] to hold large stocks. One Durban supplier [illegible] no less than 300 kinds of lamps of all sizes, [illegible]. Similarly a consumer requiring a motor [illegible] before he can make his purchase: (1) [illegible] current or direct current; (2) pressure; (3) number of [illegible].

The author, in the original Paper, proceeds to consider the subject [illegible]

Systems.—(1) Class of current, alternating or direct; (2) periodi- [illegible] system [illegible]

[illegible]

It is suggested that the alternating current system of generation and supply of current as a current be adopted in all new plants and for the supersession of direct current systems as soon as possible, because:—

1. It is cheap and can be extended to cover large areas.
2. It is the cheapest means of supplying power and heat as well as lighting.
3. All small towns should put themselves in a position to cater for power and heat.

As regards periodicity, 50 cycles per second is the periodicity fast becoming standard in Britain and the Colonies. In this country the Victoria Falls Power Co., and Johannesburg, Durban, Capetown and Port Elizabeth Municipalities have adopted it. It is very suitable in every way, allowing of good turbine and motor speeds.

Three-phase is recommended to generate and to distribute. Plain single-phase circuits can be run along streets where the load is small, and three wires where only power is catered for. It is assumed that the neutral will be grounded.

FOUR WIRES EMPLOYED FOR DISTRIBUTION.

With alternating current systems generation will naturally be at high pressure, and for the larger schemes 6,600 volt seems to be becoming standardised, being already adopted in several South African supply schemes.

Where long branches have to be led out, say, 10 miles or over, then the pressure should be stepped up, and I think we should adhere to multiples of 6,600 13,200, 26,400 volts and so on.

The settlement of a distribution pressure which will be suitable for all conditions and acceptable to all parties concerned will be very difficult.

The following points may be noted:

1. The pressure should be high to promote economy in mains.
2. It must be suitable for the lamps on the market.
3. It must suit standard heating and cooking appliances.
4. It must be reasonably economical for power supply and suit usual motor voltages.
5. It must agree with the pressures employed in most of the existing undertakings.

The following gives particulars of the pressures adopted in South Africa up to the present :—

250 volts, 4 towns (Pretoria and Port Elizabeth).
240 volts, 2 towns.
230 volts, 11 towns (Johannesburg).
220 volts, 8 towns (Capetown, Kimberley).
200 volts, 10 towns (Johannesburg, Durban, Maritzburg).
110 volts, 3 towns (East London).
100 volts, 1 town.

240 and 250 volts are uncommon pressures in South Africa, and too high for heating and cooking. Most heaters are made for 100/110, or 200/220 volts. With an alternating current system and economical transforming points one could go down to 100 volts at the lamps without spending too much on copper. It would seem, therefore, that the choice must lie between 200, 210, and 220 volts, for there are only four towns employing pressures less than these. On the whole it seems best to compromise on 210 volts.

Turning next to materials and plant, the author discusses in succession bare and covered conductors, insulators, underground mains, street lamp brackets, meters and plugs for heating utensils. Manufacturers in South Africa have to wait a long time for goods to arrive after order, and are much inconvenienced by variety in type and dimensions. At the author's suggestion the Government was asked to appoint a committee on standardisation previous to the war, and it now seems desirable to re-open the matter. The standardisation of power station plant is deferred for the present, and it is not proposed to standardise meters except by specifying sizes.

After discussion, resolutions agreeing to the following chief standards were passed :—

STANDARDS AGREED.

1. Current	Alternating
2. Periodicity	50 cycles per second
3. Number of Phases	Three.
4. Generating Pressures	415, 3,300 and 6,600.
5. Supply Pressures	240 and 480 three-wire. 240 and 415 alternating current four-wire
6. System of Distribution	4 wire three phase
7. Transmission Pressures	3,300, 6,600 and 11,000 volts.

Bare Conductors for Overhead Wires.—Nos. 12, 10, 8, 6 s.w.g. and beyond these sizes, the same sizes laid down by the British Engineering Standards Committee, but with the deletion of the following sizes :

0·125, 0·25, 0·35, leaving 0·05, 0·075, 0·1, 0·15, 0·2, 0·3, 0·4, and 0·5 square inch.

Underground Mains.—On the types of cables, it was decided to recommend that the system of protection adopted be uniform, viz., that the cables should be armoured suitable for laying direct in the ground, the sizes of conductors to be similar to those recommended by the British Engineering Standards Committee, with the deletion of the same sizes referred to in the bare conductors for overhead mains, leaving the sizes for adoption as follows:

0·05, 0·075, 0·1, 0·15, 0·2, 0·3, 0·4, and 0·5 square inch.

It was also resolved to recommend that as it was desirable that the various kinds of mains in use should be readily distinguishable from the outside without cutting the cable, that makers be asked for suggestions in regard to this matter, such as by varying the width of the standard tapes, or by introducing a steel wire or wires in the jute serving, commonly used over the armouring.

Meters.—That two two-wire meters be adopted for use on low tension supplies in preference to three-wire meters.

Sizes: 3, 5, 10, 25, 50 and 100 amperes.

Plugs for Heating and other Circuits.—This matter was referred to the Council to decide upon certain standards as regards sizes, dimensions, &c.

On the proposition of Col. Dobson, Mr. C. J. [illegible] was elected a member of the Association.

On the proposition of Col. Dobson, it was resolved to hold a meeting of the Council at 9 [illegible] the following morning to consider Standardisation and Wiring Rules.

Physical Society.

A meeting was held on the 25th ult. at the Imperial College of Science, when the Presidential Address was delivered by Prof. C. V. Boys, F.R.S. The following is an abstract of the address:—

The exigencies of the war had seriously impeded the work of the Physical Society, and all our scientific institutions. Many members were at the front; many others were busy on war work, and there was little time available for normal scientific pursuits. Since his predecessor's address, the scientific community had been stirred to an extent which he thought was unnecessary by the passing of the Daylight Saving Act. Scientifically the thing was a sham, and as such was naturally distasteful to us; but the community at large was not scientific, and had a very vague notion of the meaning of time. In the stress of war the public had realised the desirability of starting the day earlier to save not daylight but paraffin and gas, and the simple operation of putting all the clocks wrong, though hateful in principle, did not disturb the public at all.

In reference to the question of the metric system, this was important in relation to education. He believed the reason why English schools were so backward in mathematics was that so much of the available time had to be devoted to memorising tables of weights and measures and similar medieval relics.

Another matter of public importance was the recognition of science as an element of general education. It is sometimes urged that our officials need not be scientific, because they can get all the scientific advice they want. But they may not know when they require it, or appreciate the force of it when they get it. He might instance in this connection the wasteful method of street darkening which still prevails after three years. The annual trouble with frozen water pipes was another example of the general ignorance of scientific principles. Burst pipes were unknown in really cold countries where the elements of common sense were allowed to prevail.

All his own contributions to physical science had been experimental, and some words on the art of experiment might not be out of place. In order to succeed as an experimentalist it was necessary to find by personal experience how as many materials as possible behave under as many conditions as possible, and this can only be done by one who will practise every art and use every tool and instrument that he can. While endeavouring at first to imitate the practices of the professional mechanic and acquire as much of his skill as possible, the experimentalist must not be bound by tradition and custom in his methods. It is the slavery to tradition and practice that makes the assistance of the professional so tiresome to the experimentalist. In this connection a saying of Fresnel had greatly impressed him—"If you cannot saw with a file and file with a saw you will be no use as an experimentalist," or words to that effect. He had made it his business to use every tool and to handle every material that he could. On one occasion he had had the somewhat rare opportunity of handling five or six large uncut diamonds each as big as a walnut. Glass blowers are familiar with the difference in the contact of freshly blown bulbs and of bulbs some time blown. But the contact of diamonds was unlike either. When brought lightly into contact they emit a curious squeaking note of possibly 2,000 vibrations per second. This meant that the diamonds were bouncing with slowly diminishing excursions of 1/80,000 of an inch approximately, a phenomena only possible with a material of such perfect elasticity or hardness. It was possible that a test of this kind might be useful for discriminating between the hardness of the harder materials. The whole question of what hardness was, and if, indeed, it were really a definable quantity having definite dimensions, was one to which the attention of physicists could profitably be diverted. Another such question was that of the oiliness of lubricants. This appeared to depend on something other than viscosity. Animal and vegetable oils lubricated better than mineral oils of the same viscosity.

Volunteer Notices.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Oxford-street, W. 1.

Officer Commanding, Lieut.-Colonel C. B. Clay, V.D.

Orders for the Week.

Officer of the Week: Lieut. C. F. [illegible].

Next for Duty: Lieut. W. F. A. [illegible].

Monday, Feb. 11.—No. 3 Company, 6.30–8.30. Recruits' Drill, 6.30–8.30. Signalling Section, 6.30–8.30.

Tuesday, Feb. 12.—Lecture on [illegible]. Recruits' [illegible], 7.30.

Wednesday, Feb. 13.—No. 1 Company, [illegible], 6.30–8.30. Recruits' Drill, 6.30.

Thursday, Feb. 14.—No. 2 Company, [illegible]. Recruits' Drill, 6.30–8.30. Signalling Section, 6.30–8.30. Ambulance Section, 6.30–8.30.

Friday, Feb. 15.—Musketry, 6.30–8.0.

Saturday, Feb. 16.—[illegible] for the week [illegible]. Recruits' Drill, 2 to 4.15.

Special Notice.—All Drills will take place at Headquarters unless otherwise stated.

Recruits are wanted for [illegible] with the Companies.

The Medical Officer will attend on Tuesday evening for [illegible] of recruits at 6.0.

N.C.O.s and men may attend parades with companies other than those to which they are posted.

Legal Intelligence.

The British Thomson-Houston Co.'s Appeal.

After a hearing which lasted nine days, judgment was reserved yesterday in the House of Lords at the close of the hearing of an appeal by the British Thomson-Houston Co. against an order of the Court of Appeal affirming a judgment of Mr. Justice Astbury. The facts were given in our last issue.

The appellants' case was argued by Mr. Walter, K.C., and Mr. Colefax, K.C.

On Feb. 1 Mr. T. TERRELL, K.C., opened for respondents. He began by showing what was common knowledge with regard to tungsten at the time when the patent was granted to appellants in 1906. After defendants (now respondents) had put in amended defences, they, to avoid inspection of their works, made a formal admission on the issue of infringement in these words: "The defendants formally admit, for the purposes of this action, that they in the course of their manufacture of tungsten wire subject the metal tungsten in a coherent form to the action of heat while it is being operated on or manipulated." This admission precisely followed the words of the first claim of appellants' specification. Therefore the alleged invention claimed in the specification was in respect of ductile or malleable tungsten for whatever purpose it was to be used. To that claim defendants pleaded (1) that the alleged invention was too wide and general, and that there was no subject matter for a patent disclosed, having regard to common knowledge of metallurgy in general and of tungsten in particular; and (2) that the invention described and claimed had been anticipated. It was so wide, Mr. Terrell went on to argue, that it could include any manner of working, whether by forging, hammering, rolling or drawing coherent tungsten however obtained, in a coherent form and at any degree of temperature "while it was being operated on" in any manner, and consequently had been anticipated by Siemen's specification, and more particularly by Moissan's publication, which disclosed a method of production of pure coherent and compact tungsten. In short, all the specification consisted of was an alleged discovery that tungsten could be worked hot. Therefore the Courts below were right in holding that appellants' specification involved no invention such as would support a patent at law. It was, therefore, invalid for want of subject matter.

Mr. KERLY K.C., followed on the same side, and Mr. WALTER, K.C., having replied, their Lordships reserved judgment.

Patent Record.

APPLICATIONS FOR PATENTS.

*NOTE.—The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application an asterisk is affixed.*

January 12, 1918.

[illegible]

January 14, 1918.

[illegible]

790 WATKINS. Tools for manipulating shade holders.

809 B.T.-H. Co. (G.E. Co.) Electric welding systems.

[illegible]

January 15, 1918.

[illegible]

861 B.T.-H. Co. (G.E. Co.) Electric fans.

[illegible]

January 18, 1918.

[illegible]

January 19, 1918.

[illegible]

January 21, 1918.

[illegible]

Commercial Topics.

Excess Profits Duty.

The Board of Referees has increased the statutory percentage for the business of manufacturing in a malleable form metallic tungsten and molybdenum direct from the ore or from metallic salts, with or without the manufacture of chromium from chrome ore, at 12 per cent. in the case of companies or other bodies corporate and 12 per cent. plus 2 per cent. for accounting periods ending after Dec. 31, 1916, in the case of other businesses.

* * * *

British Trade Organisation.

In connection with the movement to secure a re-organisation of British industry, the Federation of British Industries has appointed a committee, consisting of Sir William Peat, Sir Francis Barker and Mr. E, Fitzjohn Oldham, to give any advice and assistance which may be required by any trade which is considering the question of its organisation.

The committee will be ready at any time to consider any inquiries, or to render assistance or advice either by correspondence or personal discussion with representatives of any such trade. Letters should be addressed to the Director of the Federation of British Industries, 39, St. James's-street, London, S.W. 1.

* * * *

Work of Ministry of Reconstruction.

The Minister of Reconstruction (Dr. Addison) recently explained to a gathering of Press representatives the work already accomplished by his Department. The Ministry has set up a General Advisory Council, consisting of four sections. One would deal with production and commercial organisations; another with finance, transport and common services; a third with labour and industrial organisation; and a fourth with social development, including agriculture, education, health and housing (as stated in our last issue).

Dr. ADDISON said the supply and control of raw materials after the war was already engaging serious attention, as was the question of priority in importance of all imports. The preservation of old industries and the establishment of new ones was being dealt with by special committees; whilst others were devising plans for the provision of sufficient working stocks in various branches of industrial activity. Arrangements had been made for dealing with the disposal of Government war stores when hostilities were over, by means of which he hoped they would avoid the scandals which had followed every war. He regretted they were not making the progress for which he could wish in regard to the setting up of joint industrial councils to deal with the difficult technical questions connected with re-instatement and trade pledges. Their scheme for Army demobilisation was complete. Every unit would know which of the men in its ranks had their places kept open for them; it was believed that would apply to 60 per cent. of the Army.

* * * *

British Trade with Italy.

At a meeting of the London Chamber of Commerce last week Lord Hythe read a Paper on "Anglo Italian Trade Relations."

Lord HYTHE said that in the autumn it was suggested to the British-Italian Commercial Association that he should make some sort of inquiry as to the best lines to be followed if Great Britain would take the place of Germany in the Italian market. He had visited Rome, Milan, Leghorn, Genoa, Naples and other towns, and saw leading industrialists in each place. Among the openings for British trade the most important were machinery and textiles. There was a great opening for British manufacturers in the supply of electrical machinery, as well as in the supply of textile and agricultural machinery, sewing machines, machine tools, &c. Every sort of household requisite, from pots and pans to door handles and writing table furniture, had hitherto been mainly supplied from Germany. It was probable that Italy would before long make for herself many of these articles, but at present there was a good opening for British products. If British manufacturers were to capture any proportion of the Italian market it was necessary they should follow the example of the Germans in many respects. Principals should visit the country to study the conditions of the market. British manufacturers in various lines should co-operate instead of competing with each other. Agents or travellers, if English, must be able to speak Italian, or at any rate French. Quotations and invoices should be in Italian lire and in metric, not English, measures.

* * * *

Electrical Supplies for Canada.

In "The Times" Trades Supplement for February a correspondent emphasises the fact that the development of the water power of Canada is proceeding rapidly, particularly in Ontario, Quebec, the Maritime Provinces and British Columbia, and with this development has grown a big demand for electrical plant and supplies. The present power utilised exceeds 1,700,000 H.P., and the possibilities of areas expected to the populated in the near future aggregate 17,750,000 H.P. Practically the whole of the electric motors and generators imported by Canada in the year before the outbreak of war, and valued at £160,000, were supplied by the United States. Statistics showing the value of the exports from the United Kingdom

are not available, but British exports to Canada of all kinds of electrical machinery were valued at only £118,160. The Dominion's total imports of all kinds of electric apparatus were valued at £1,750,000, the shares of the United States and the United Kingdom being £1,500,000 and £192,000 respectively.

Under existing circumstances it is impossible for British manufacturers to turn their attention to Canadian requirements; but with sentiment so strongly in favour of Great Britain an endeavour should be made to capture a larger share of this important business after the cessation of hostilities.

In addition to the demand for heavy plant and machinery, there exists an extensive and continuous demand for insulators, batteries, telephone and telegraph instruments, wiring, globes, shades, &c., the annual purchases of these exceeding £1,300,000. No traveller through Canada can doubt that the prevalence of American travellers is responsible for much of the success of United States firms. In addition, the latter have a distinct advantage over their British rivals in their methods of standardisation and business organisation. Where travellers can be spared by firms in Great Britain they should be commissioned to visit Canada as soon as possible for collecting information relative to commercial conditions and requirements, making a special feature of the investigation of the methods adopted by their American competitors. Technical knowledge on the part of the traveller is indispensable in the electrical industry.

* * * *

Industrial Councils.

The "Manchester Guardian" reports that the Ministry of Reconstruction and the Government Departments concerned are disappointed at the slow progress that is being made in the formation of industrial councils. The London correspondent of our contemporary states that "by way of pushing the scheme forward, the Ministry of Reconstruction, the Ministry of Labour and the Board of Trade have combined to promote the formation of committees in various trades whose business it will be to organise these councils. These committees will represent both sides of the industries. The difficulty has been that the trades are jealous of Government interference, and what is wanted is to bring about movement from within. I believe that the pottery industry is still the only one that has an industrial council actually at work, although the brass and leather trades and some others have got schemes well in hand. I hear that the Lancashire coal miners are taking a special interest in this matter just now."

* * * *

Enemy Businesses Wound Up.

In the House of Commons on Wednesday Mr. Wardle stated, in reply to a question, that he was unable to say how many persons, firms or companies of enemy nationality were carrying on business in this country at the commencement of the war.

The total number of cases in which orders to wind up or discontinue businesses had up to the present date been made under Sec. 1 of the Trading with the Enemy Amendment Act, 1916, was 502. It was believed that most (if not all) businesses of any importance had been dealt with under the provisions of the Act of 1916.

The total number of orders made by the Board vesting property in the custodian under Sec. 4 of the Act of 1916 was 913. Out of this number 132 were orders relating only to the property of enemy subjects residing in this country; some of the remaining orders had dealt with the property of enemies as well as that of enemy subjects residing in this country.

The President of the Board of Trade was forwarding to the Home Office particulars of certain naturalised British subjects of enemy origin to whom he referred in the debate on the Non-Ferrous Metal Industry Bill as having conducted their businesses since the war without proper regard to the interests of this country.

Electricity Supply.

Extensions.

Bolton.—The L.G. Board have sanctioned the borrowing of £60,000 for the extension of the electricity works.

Dublin.—The Electricity Supply Committee recommends that application be made for sanction to a loan of £1[illegible],000 for extensions of the electric supply undertaking.

A sum of £[illegible],000 would be required for new generating plant, £[illegible],000 for a tunnel under the Liffey and sub-station at North Wall, £[illegible],000 for distribution work now [illegible]. The Committee [illegible] that the question of the extensions cannot be longer delayed. [illegible] if the war should continue [illegible] the Committee feel [illegible] of being in a position to supply the full demand [illegible] the tendency to utilise electricity for power being greatly on the increase.

Emphasis is laid on the necessity for development in the North Wall area. It is recommended that [illegible] percentage on the cost of extensions be divided proportionately between Messrs. [illegible], [illegible] and Archer. Pending the construction of the proposed tunnel, the Committee, subject to Government permits, is in a position to give a supply for the most urgent sections by linking up the Clontarf feeder mains with an extension running from the North Wall to Ballybough Bridge, and by joining up with the high pressure feeder at Sir John Rogerson's Quay.

Edinburgh.—The Council are recommended to apply for powers to include Dalmeny in the electricity supply area of the city.

The Electric Lighting Committee has decided, apart from the instructions of the Ministry of Munitions, to suspend connections with the electric supply mains during the winter months and until the generating plant has been extended.

Mansfield.—The Council has applied for authority to borrow £20,500 for electric supply extensions.

Pembroke.—Application has been made to the L.G. Board for sanction to borrow £10,000 for extensions of the electric supply department.

Shoreditch (London).—On Tuesday the Finance Committee of the London County Council reported that in May, 1917, Shoreditch Borough Council was authorised to borrow £31,810 in respect of the following expenditure:

Mains (£8,725) repayable in 25 years; plant (5,000 kw. turbo-alternator, &c., £32,275) repayable in 15 years, a total of £41,000. The difference (£9,190) represented the loan outstanding on displaced plant, being provided out of the Borough Council's electricity reserve fund. The period of such outstanding loan was to be reduced to 15 years from August, 1917. The Borough Council stated that the estimated cost of the plant is now £57,180, and it applied for sanction to borrow an additional sum of £16,180. The necessity for the supplementary application arose from the fact that, since the estimate was prepared (in January, 1917) there has been an abnormal increase in the prices of engineering plant. Further, since the original estimate was submitted to the Council in September, 1913, the prices for all the plant required have greatly increased, and that the total increase in the cost of the work compared with the earlier estimate is not less than £20,000. Having regard to the circumstances, the L.C.C. was recommended to rescind the resolution of May 22, 1917, and that the borrowing by the Shoreditch Council of an amount not exceeding £47,990 be sanctioned. Of this sum the £10,425 for mains would be repaid within the last 23 years of a term of 25 years from the date of the borrowing, and as to £37,565 for machinery (turbo-alternator and auxiliary plant) within the last 13 years of a term of 15 years from the date of the borrowing.

Wolverhampton.—The Corporation has applied for sanction to borrow £28,000 for the electric supply undertaking.

General.

Aberdeen.—A mishap to a 5,000 kw. set has interfered with the supply of electric current.

It is expected that the full supply will be maintained for industrial purposes, and should the rest of the plant continue to work in a satisfactory manner, it is thought that the full tramway service will be maintained till the machine is repaired.

Aberystwyth.—A scheme is being prepared for utilising the water power available in the Rheidol Valley for generating electrical energy.

Bispham.—This district has been incorporated in the area of the Blackpool Corporation, and the Parliamentary Committee of the latter has instructed the electrical engineer to report on the utilisation of the existing electricity works.

Exeter.—The application of the employees in the electricity department for an increase in wages and bonus for certain classes of men has been referred by the Council to the Committee on Production for arbitration.

Falkirk.—The Council has granted a total bonus of 4s. per week and 12½ per cent. to workers in the electricity supply department.

Gainsborough.—Mr. James Marshall has withdrawn his application for a provisional electric lighting order for Gainsborough, though the firm are proceeding with the erection and equipment of a large power station.

Increased Charges for Electrical Energy.—The charges for current are being increased at the following places:—

Liverpool Tramways and Electric Power and Lighting Committee recommend an increase of 1[illegible] per cent. on all charges except [illegible] for tramways.

[illegible] Electricity [illegible] increase in charges from [illegible] to [illegible] per cent. for private lighting, from [illegible] for power [illegible] for traction.

[illegible]

Wolverhampton Council has made further increase [illegible] of 10 per cent. [illegible]

[illegible]

London County Council.—The Council will petition against the Bill of the County of London Electric Supply Co. and the London United Tramways (Ltd.), and also against the Canvey Water Board Wharf and Railway Bill.

Loughborough.—The salary of the electrical engineer, Mr. R. B. Leach, has been increased from £300 to £350 a year.

Salford.—It has been agreed to supply with electrical energy the new premises of J. Mandleberg & Co. in Pendleton. The supply is to be delivered as high-tension three-phase current at 6,600 volts, and a minimum payment to the Council of £600 per annum for five years is guaranteed.

The A.E.S.E. in Sheffield and District.—There was a representative gathering of engineers at Sheffield on the 30th ult., to inaugurate a branch of the Association of Electrical Station Engineers.

A deputation from Manchester was in attendance, and included Messrs. Lunn, Pousey and Thomas, the latter being secretary of the Manchester branch.

Mr. S. Edgar Fedden, general manager and engineer, of the Sheffield Electric Supply Department, presided, and opened the meeting with some explanatory remarks regarding the status of the present-day power engineer and his future position when the recommendations of the Whitley report were carried into effect.

Messrs. Lunn and Pousey spoke on the Association of Engineers and the increase of efficiency created by the interchange of ideas that would accrue through being members of the Association. Mr. Thomas gave a general review of the policy of the Association.

A resolution to form a local section was carried unanimously. There were representatives from Barnsley, Hull, Leeds, Mexborough and Rotherham, and apologies were received from several engineers in the district, who were unable to attend.

Wallasey.—The salary of the electrical engineer, Mr. J. A. Crowther, will be increased by £100 per annum as from March 31.

West Bromwich.—The Council will lodge a petition against the Shropshire, &c., Electric Power Bill.

Application is to be made to the L.G. Board for sanction to borrow £1,5[illegible] spent on mains extensions.

Lighting and Industrial Power.

Islington (London).—A report upon the present and future electric lighting of the streets of the borough has been prepared by Mr. Haydn T. Harrison, M.I.E.E.

Certain questions were put to Mr. Harrison, who, after setting out his views and arguments on the subject of electric street lighting, replies as follows:—

In my opinion the whole of the electric street lamps in the borough should be converted to gas-filled (half watt) lamps as and when means are available for carrying out this work in such a manner that the illumination can be easily and promptly raised to the standard likely to be demanded in future, the scheme for raising such illumination to be [illegible] not exceeding 1,000 c.p. each can be used. Such a scheme is described in this report.

Short parallel circuits should be adopted. The estimates of cost prepared by the electrical engineer (Mr. A. Gay) were as correct as it was [illegible] considering the difficulty of forming an opinion as to when the metal and labour markets are likely to become [illegible].

As half-watt lamps will be procurable in various candle-powers, I [illegible] of the lamps used should be based on the [illegible] and the distance apart of the lamp-posts, the standard of illumination necessary being settled by [illegible] by virtue of their knowledge [illegible]

[illegible] of the parallel circuit at the [illegible] and when a [illegible] to be half-watt [illegible] to the parallel [illegible] would [illegible] the cost of the alter- [illegible]

[illegible] illumination adopted in the various districts. If the number and positions of [illegible]

[illegible]

Port[illegible] [illegible]

Electric Traction.

Bradford.—The Tramways Committee has passed the following resolution:—

"That in the opinion of this committee the time has now arrived for the tramways manager (Mr. C. J. Spencer), who has been engaged for more than a year on work for the Admiralty, to return to Bradford in order to resume active control of the tramways undertaking, which, while always requiring careful handling, is at the present time more than ever in need of the manager's personal and continuous supervision, and that the Town Clerk be instructed to communicate with the Admiralty and request them to release the tramways manager at an early date."

Mr. Spencer, in a statement made to the committee, said that all he was anxious to do was to give his best services to the country, and that he was ready to undertake duties under any authority if he was considered to be doing his best for the national cause. He quite realised that the tramways undertaking required his personal supervision, and was prepared to resume his former duties if the authorities were so minded to dispose of him.

Colne.—The Council has decided to renew and to relay certain crossings and lengths of the tramway track, and the Board of Control has been asked to consent to the work being carried out at an estimated cost of £3,320.

Dundee.—At a special meeting of the Tramway Committee on Monday there was a lengthy discussion on the proposal to curtail the tramway service.

Some time ago the tramways manager (Mr. P. Fisher) received a communication requesting him to state exactly the cars needed to meet the industrial needs, and how much of the line was used for purely residential travelling. A further communication from the Board of Trade had now been received, asking how many cars could be spared, the length of the rails and the number of standards.

Several members pointed out that, instead of sacrificing any cars, more were really required.

Mr. Fisher outlined the nature of the reply which he proposed should be sent to the inquiry. This was to the effect that a considerable portion of the "tail ends" of practically all the routes should be cut off.

Ultimately it was left to Mr. Fisher to explain the position, the Committee recognising that if the demand was insisted upon it would have to be met by a drastic restriction of the present service.

Kirkcaldy.—Owing to the shortage of labour the tramcars of the Wemyss & District Tramways Co. will in future stop at Gallatown instead of running through to Kirkcaldy.

The District Committee has petitioned the Board of Trade regarding the unsatisfactory state of the Wemyss district tramway route.

At the recent meeting Councillor Cormie said the tramway was a menace to the safety of the people of the district. Only the other day a serious accident occurred through two cars meeting each other on a single line. Passengers never knew whether they were to get to Kirkcaldy that day or the next, and two or three hours to the journey was quite common.

Mr. J. M. Smith, Leven, said that in making the short journey from Methil to Leven he was ordered out three times, and did not get to his destination when all was said and done. There were frequent breakdowns in the service, and the way the cars were run was scandalous.

Liverpool.—The Tramways Committee has decided to advertise for a deputy general manager of the tramways undertaking at a salary of £800 per annum.

L.C.C. Tramways.—On Tuesday the Highways Committee reported that they had sanctioned expenditure not exceeding £2,500 for the welding and repair of rail joints for the tramways in Wandsworth-road, between Nine Elms and Clapham Junction, by a process not hitherto adopted on the Council's tramways, and they had arranged for the work (including 12 months' maintenance) to be carried out by the Tudor Accumulator Co., at a cost of 53s. 6d. a joint.

Arrangements have been made for giving temporary supplies of power from Greenwich station on emergency to West Ham Corporation and St. Pancras Borough Council.

On Tuesday a supplementary estimate of £2,400 was passed for increasing the wages of persons employed at the Greenwich power station and the tramway sub-stations. The increase is due to the additional war wage of 5s. a week recently awarded by the Committee on Production to the engineering and foundry trades.

The registered address of the principal office of the tramways department has been removed to 23, Belvedere-road, from 62, Finsbury pavement, E.C.

Norwich Electric Tramways.—The Board of Trade has extended by a further period of one year from July 31, 1918, the period limited by Norwich Electric Tramways Act, 1914, for the compulsory purchase of lands, &c.

Road Transport Board.—The President of the Board of Trade with the concurrence of the War Cabinet, has decided to appoint a Road Transport Board to co-ordinate the work of existing Government Departments in connection with road transport; to determine what further measures are necessary to ensure the most economical use of road transport vehicles and their efficient allocation for meeting such requirements as may arise from time to time for the transport

of food, &c., and, subject to the direction of the Board of Trade, to give executive effect thereto.

The Board will consist of representatives of each of the following departments: Board of Trade (Petrol Control Department), Board of Trade (Horse Transport Department), Ministry of Munitions, Ministry of Food, War Office, and Post Office.

The Board will exercise its executive functions through Divisional Road Transport Boards set up in each of the 15 Divisional areas of the Food Commissioners, consisting in each case of: A Road Transport Officer (appointed by the Board of Trade), the Divisional Food Commissioner of the Ministry of Food or his representative, the Local Transport Officer of the Ministry of Munitions or his representative, with two representatives of local interests, the chairman being the Road Transport Officer. Sub-Committees will be appointed by the Divisional Boards to deal with sub-areas of their Divisions.

The new Board will (says the "Board of Trade Journal") take into consideration, among other things, the following proposals:—

(a) The registration of vehicles, whether driven by petrol, steam, gas, or electricity, or horse-drawn, in such a way that any of them could be rapidly called upon in any district should emergency arise.

(b) The preparation of a priority scheme for the use of such vehicles in emergency.

(c) The preparation and putting into force of local schemes for co-ordination and economy in the use of horse and mechanical transport by traders, Government departments, and others.

Sunderland.—The Tramways Committee has allocated £5,000 out of the net profit (£12,500) on the year's working to the relief of rates.

Tramway Fares. In reply to a question by Mr. J. D. Gilbert, the President of the Board of Trade (Sir A. Stanley) stated in the House of Commons on the 31st ult. that the Tramways Committee had recommended that to enable tramway undertakings to meet the increased cost of labour and materials, powers to increase statutory maximum tramway fares should be obtained by the Board of Trade. At present the Board had no general powers of that kind, and the question whether such powers should be sought was being considered.

York.—The tramways manager (Mr. J. W. Hame) has reported to the Tramways Committee on the working of the tramways and has made the following recommendations:—

(1) That the Dringhouses route should be linked up with the Hull Road (instead of South Bank and Hull Road), for a six cars per hour service, and Acomb and South Bank should run Fulford to Haxby-road; (2) that the price of dinner hour and War Office tickets be increased by a halfpenny for each return journey, (b) that the War Office quarterly contract tickets be discontinued, (c) that preliminary steps be taken to obtain powers for authority to charge increased fares; (3) that the fares from the Acomb section be increased.

The Town Clerk also informed the committee that the Board of Trade have under consideration the general question of authorising an increase in maximum fares. The committee recommended the Council to adopt the tramways manager's suggestions, but propose to postpone for a time any active steps with regard to the increase of maximum fares.

In presenting the minutes of the Tramways and Electricity Committees at the meeting of the Council on Monday, Ald. [illegible] said they proposed on March 1 to increase the fares to the maximum of a penny per mile. Ultimately they proposed to ask for power to increase the maximum, as it was impossible for tramway undertakings all over the country to carry on at the present fares. There was no other system in the country where dinner hour tickets were given. As regards the electricity undertakings, owing to Sir George Askwith's award of £1 per week above pre-war scales plus 12½ per cent., the charges must be increased.

[illegible]

The Council finally agreed to accept the following recommendations: [illegible]

Telegraphy and Telephony.

The Telephone in Egypt. [illegible]

[illegible]

Imperial Notes.

Australasia.—The "Australian Mining Standard" says the Council of Melbourne University is considering a proposal for instituting degrees in industrial science.

The Faculty of Science at the University recently prepared a report on the subject, in which they expressed the opinion that if the Government scheme for a bureau of science and industry were carried out completely there would be many openings for scientific workers, and the Faculty suggested courses for such workers. The laboratory would require extension, and new expenditure would be involved for the new degrees other than the physics degree, which could be instituted by regrouping the subjects already taught. The following are amongst the proposed new degrees (in order of urgency) and the estimated cost: Metallurgy £500, chemistry £11,000, physics (no additional cost). The Council of the University resolved to submit the report to the Government with a request that it should be placed before the executive of the Commonwealth Advisory Council of Science and Industry.

A new source of electric power for Melbourne is about to be provided at the Victorian railway workshops, Newport. The electric power-house for the suburban railways will be in commission about the end of March. The Railway Commissioners can sell the surplus current in bulk for industrial purposes. The Commissioners hoped to have the necessary material to operate the first electric line (from Broadmeadows to Sandringham) by the middle of this year, but owing to war conditions it is impossible to say when the whole suburban system will be complete.

Tasmanian Hydro-electric Works.—The third annual report of the chief engineer and manager of the Tasmanian Government's hydro-electric department (Mr. J. H. Butters) has been issued. The first section of the hydro-electric scheme was completed during the past financial year at a cost of £471,766, while a further £35,760 has been expended on the second section, making a total of £507,526. Parliament has also voted £171,000 for the extension of the second stage. The work includes the construction of wood and steel pipe lines, the extension of the transmission line to North-West Bay, and the erection of sub-stations at New Town to supply the Electrolytic Zinc Co., and at North-West Bay to supply the Hydro-Electric Power & Metallurgical Co.'s carbide works. The hydro-electric undertaking was put into commercial operation on Aug. 15, 1916, and the results of the first year's work are said to have been eminently satisfactory.

The only contract of importance entered into during the year was one with the Hobart Corporation for the supply of power for the municipal tramways and for the supply of current in the central portion of the city. Early in February, 1917, the Risdon works of the Electrolytic Zinc Co. of Australasia (Pty.), Ltd., were sufficiently advanced to enable them to take a small supply of power, and from then until the end of the year power has been supplied to them continuously. The company has made excellent progress towards the completion of the first portion of its works—viz., the erection of its 10-ton plant. It has expended during the year nearly £170,000, and it is anticipated that the total expenditure will be £200,000.

The Hydro-Electric Power & Metallurgical Co. has made excellent progress towards the completion of the first unit of its calcium carbide works, and hopes to be ready for work at an early date.

The Hobart district branch of the department's undertaking provided [illegible] office, and had available a balance sufficient to make a contribution of over 1 per cent. on the whole of the capital invested in the district to a depreciation fund. The debit balance of the department was £10,317 after meeting all expenses, including interest. The extra revenue from the supply of power to the zinc and carbide works would more than wipe off this balance when the new transformers have been connected for 12 months. When the second stage of the works was completed, and only [illegible] working expenses, meeting the interest bill in full, and contributing about [illegible] on the second stage; whilst there would be a surplus capacity in the [illegible]

[illegible]

Economising Power in Canada.—Owing to the increasing demand for power, the Ontario Hydro-Electric Commission has prohibited the use of electrical energy for advertising signs, &c., and it is discontinuing cluster lighting and reducing street lighting. In this way the Commission will save 50,000 H.P.

The Electric Furnace in Canada.—At the recent meeting of the Commission on Conservation at Ottawa, the chairman (Sir Clifford Sifton) stated that an interesting investigation had been made regarding the development of the electric smelting problem. At present there were in Canada 32 Héroult electric furnaces and 22 of other types. Those furnaces had a capacity of 173,000 tons of iron and steel, 50,000 tons of ferro-silicon and 8,000 tons of other ferro-alloys per year. The British forgings plant at Toronto had 10 Héroult electric furnaces, with an annual capacity of 72,000 tons.

Miscellaneous.

A Food Transport Director.—Mr. George J. Gibson, traffic manager of the Manchester, Sheffield and Nottinghamshire section of the Great Central Railway, has been appointed Director of Railway Transport, Ministry of Food.

Before entering the service of the Great Central Railway, 14 years ago, Mr. Gibson held various positions on the London & South-Western Railway, and for some months last year he was acting superintendent of the Great Central Railway during the absence of Major Clow, the superintendent of the line, who went to France on special duty.

Callender's Hospital and Distress Fund.—The report of the Committee for the year ended Dec. 31, 1917, states that the total amount received (£412) was the highest on record.

The annual awards to hospitals and other institutions totalled £297 (compared with £281 in previous year) and financial assistance, amounting to £40, was given to applicants, besides 226 hospital and 12 home nursing letters, and a large number of surgical appliances, spectacles, &c. The penny weekly subscriptions amounted to £322 (against £288), and the donations included £50 from the Company, £10 from the Volunteer Munitions Brigade Sunday Squad, £5 5s. from Mr. T. O. Callender, and one of two guineas each from directors and others.

Cobaltcrom High Speed Steel.—It has been found that the best result with cobaltcrom high-speed steel is obtained by allowing it to cool in the furnace to some extent after reaching a cherry-red heat. In order to enable this operation to be carried out conveniently, "Perek-" heat indicator compounds are now in use. These are introduced into the muffle furnace after the tool has reached a cherry red, after which the gas is turned off and the compound is watched until it begins to solidify. At this point the tool is withdrawn and exposed to still air to complete the hardening operation. Further information can be obtained from Messrs. Darwin & Milner (Ltd.).

Combination of French Electrical Engineering Firms.—The Compagnie Française pour l'Exploitation des Procédés Thomson Houston [illegible] has taken over the business of L'Eclairage Electrique. The French Thomson Houston Co. has a capital of about £2,400,000 and L'Eclairage Electrique about half a million.

[illegible] to be effected by an exchange of shares, after [illegible] Thomson Houston Co. will make a further issue for cash. [illegible] of the Company will eventually stand at £4,800,000 [illegible] the carrying out of important electrical [illegible] especially in the nature of railway electrification. The [illegible] Thomson Houston Co. appear to have an issue of [illegible] to the amount of half the existing capital, [illegible] expected to be raised [illegible]

Electricity and Gas Economy.—The controller of coal mines (Mr. [illegible]) writes to say that, in view of the necessity of reducing the [illegible], and of the labour and transport to handle [illegible] the attention of all consumers of gas and electricity [illegible] to the need of the greatest possible [illegible]

[illegible]

Endowment Research.—The trustees of the late Dr. Ludwig Mond have paid over the sum of £66,500 in 5 per cent. war stock to the trustees of the endowment fund of the Davy-Faraday Research Laboratory of the Royal Institution.

Engineers' Wages and Manufacturers' Costs.—Sir Geo. Askwith, in forwarding to Southwark Borough Council his recent decision regarding an increase in war wages, expressed the opinion that all contracts entered into prior to the award by electric undertakers and electric contractors with Government and civil customers should be subject forthwith to revision, with a view to meeting the extra cost which has had to be incurred owing to the back date at which it has been necessary for the decision to come into force, as well as future costs.

Sir Geo. Askwith also expressed the opinion that steps should be taken, in necessary cases, for the raising of maximum prices in provisional orders and special acts. There are a number of consumers whose contracts have not been affected by the war percentages that have had to be made upon the charges for current supplied.

The Electricity Committee has therefore decided to make a further charge of 10 per cent. to consumers in respect of power, lighting, heating, &c., and that a war percentage of $33\frac{1}{3}$ per cent. be charged to all consumers holding contracts with the Council not affected by the previous revision of prices, such increases to take effect as and from the 31st prox., and also the coal clauses, fixing the chargeable limit at 20s. will be varied from 20s. to 15s. per ton.

Increasing the Egg Harvest.—There can be no two opinions regarding the value of the egg as an article of food, and were it not for the high prices now being asked for eggs of any age the public would not be so concerned by the shortage of meat and fish. Any method that promises rapidly to increase the country's production of eggs is a matter of national importance, and merits the closest attention. It is better and cheaper to increase the yield from existing birds than to add to their number. This can be done quite readily and at small cost by any amateur within reach of an electric supply main, the system being one that has been adopted successfully for some years by poultry experts. It consists merely in prolonging the hours during which the fowls remain awake, and continue, therefore, to scratch about, to eat and to give their attention to egg laying.

During the height of summer the hours of darkness are few, yet they are sufficient for the health of the fowls, so that the longer nights during the rest of the year provide merely an excess of rest. By installing one or two Mazda electric lamps in the hen house and switching them on before sunrise in the winter and again in the evening a very substantial increase in the output of eggs can be assured. Many cases might be quoted to show actual increases in egg-production by lengthening the working day in this manner; but it will be sufficient to quote the experience of a poultry keeper with 100 hens. With conditions as nearly as possible identical during the five months from September to January in two consecutive years, the yield of eggs was 3,458 and 6,626 respectively, the higher figure being obtained after a 100 watt Mazda lamp had been installed in each hen house. These lamps were switched on at six o'clock every morning for about an hour and after dark till nine o'clock, a dim light being left on to enable the hens to find their perches. The *additional* eggs thus produced, at current retail prices, would be worth about £60, the cost of extra food, of the wiring and lamps, and of the current consumed being about £15. After paying off the entire cost of the equipment, a surplus of £35 remains, so that, apart from increasing the supply of home-produced food, the poultry keeper stands to make a substantial profit.

Inquest.—At Sheffield on Friday an inquest was held on Wm. H. Brookes, steel smelter at Messrs. Swift, Levick & Sons, who was killed on the 30th ult.

Deceased and a fellow workman went into the power house to make a small repair, and he tripped over some cables lying on the floor. In attempting to save himself from falling he grasped a live wire, carrying current at 2,000 volts. His companion, in trying to rescue him, received a severe shock and was unable to call for help for about 20 minutes. When the current was turned off, Brookes was found to be dead, his right hand being burnt away. Deceased was not allowed in the power house, but had only gone there in the absence of the electrician to do what was the latter's work.

The jury returned a verdict of death from electric shock, and found that no blame attached to anyone.

Maximum Iron and Steel Prices.—The Minister of Munitions has fixed the maximum basis price for bar iron at £16 per ton from Jan. 1, without extra allowance for tensile quality in the case of steel in shell discard quality.

Prohibition of Swedish Exports.—The Swedish Government has prohibited the export of glass and glassware of all kinds.

Reconstruction.—In the House of Commons last week the Minister of Reconstruction (Dr. Addison) stated that two further reports from the Whitley Reconstruction Committee had been received, relative to the application of the first report to less organised industries and workshop committees. These reports were under consideration.

Technical Teachers' Salaries.—A meeting of teachers engaged in the technical institutes, junior technical schools and trade schools of London and neighbourhood was held at the Polytechnic, Regent-street, W., on Saturday last, to consider the question of salaries.

Mr. P. Abbott, B.A., presided over a large attendance. Emphasis was laid on the fact that the salaries paid in institutions of the above-named types compare very unfavourably with those paid in industry and in secondary schools. A resolution declaring that the present rates of salaries paid to both day and evening teachers in technical institutions are totally inadequate and urging educational authorities to take immediate steps to establish satisfactory scales of salaries for all teachers was carried unanimously.

A further resolution that State grants, similar to those given in the case of secondary and elementary schools, are urgently needed for improving the salaries of teachers in technical schools and institutes was also unanimously adopted.

It was agreed that the London branch of the Association of Teachers in Technical Institutions should request the County Councils of London and the Home Counties to receive a deputation to place before them the views of the meeting.

Trading with the Enemy.—The "London Gazette" of Feb. 1 contains additions to the list of persons and firms with whom trading by persons and firms in the United Kingdom is prohibited.

The additional names include: *Denmark.* Siemens-Schuckert Dansk A/S (Copenhagen).

Tenders Invited and Accepted.

Turbo-Alternator and Condensing Plant.

The Corporation of the County Borough of NEWPORT (Mon.) invite tenders for (section 1) 3,000 kw. turbo-alternator and (section 2) surface-condensing plant for 3,000 kw. turbo-alternator. Form of tender, &c., from Mr. A. Nichols Moore, M.I.E.E., borough electrical and tramways engineer, Town Hall, Newport, Mon. Tenders by 10 a.m. Feb. 18 to Mr. Albert A. Newman, town clerk.

Tramcar Wheel Tyres.

LONDON COUNTY COUNCIL requires tenders by 4 p.m. Feb. 18 for supply of 4,500 Forged Steel Driving Wheel Tyres and 3,000 Forged Steel Trailing Wheel Tyres for electric tramcars. Forms of tender from the General Manager of the Tramways Dept., 23, Belvedere-road, Lambeth, S.E.

Tramway Stores.

CROYDON Corporation require tenders by 10 a.m. Feb. 18 for three, six or 12 months' supply of general stores and goods for their tramways department. Schedules, &c., from the Tramways Manager.

Telephone Material.

Tenders are invited by Feb. 27 for supply and delivery to the Postmaster-General's Department of South Australia of Telephone Material as per schedules 479 and 483. Specifications, &c., from the Commonwealth Offices, Australia House, Strand, London, W.C. 2.

CARDIFF.—The Electricity Committee has accepted the tender of the British Electric Transformer Co. for a transformer at £102. 10s.

GLASGOW.—The Tramways Committee have placed orders with F. Smith & Co. for trolley wire and with P. R. Jackson & Co. for armature coils.

LONDON COUNTY COUNCIL.—The following tenders have been accepted by the tramways department of the County Council:

Hadfields (Ltd.), 100 driving wheel centres, at £4 17s. 6d. each; Hurst, Nelson & Co., eight truck sides, £112; London Electric Wire Co. & Smiths (Ltd.), cotton covered copper wire (items 1, 3 and 4), £925; Midland Electric Wire Co., cotton covered wire (items 2 and 5 to 9), £5,740; John Crowley & Co., iron castings, £250.

For re-winding the armatures of tramcar motors the following contracts have been let:—P. R. Jackson & Co. (£476 5s.), Drewer, Stevenson & Co. (£224 5s.), British Westinghouse Co. (£167 10s.), H. Dunn & Son (£340), Armature Repair Co. (£18 [illegible]), Electrical Repair Co. (£360), Burdett & Co. (£315), and Collins Electrical Co. (£160).

Tenders were received from the undermentioned firms for the supply of 400 of each of two types (classes 200 and 220) and 200 of each of two types (classes 3x and 24x) of field coils for tramcar motors:—Manchester Armature Repair Co., Brush Electrical Engineering Co., British Westinghouse Co., Armature Repairing & Supply Co., Johnson & Phillips, Electrical Repair Co. The offers of the Manchester Armature Repair Co. have been accepted for the supply of all the types of coils except those of class 200, the offer of the firm being accepted for 200 coils of this type, the remainder (200) being obtained from the Brush Co. The total expenditure involved will amount to about £8,980.

STEPNEY (LONDON).—The Borough Council has accepted the tender of the British Thomson-Houston Co. for the supply of oil filtering apparatus, at £1[illegible] 10s.

JOHANNESBURG.—The Municipal Council has accepted the following tenders:

[illegible] Engineering Co., 100 k.v.a. transformers, £1,280 and meters, £112 10s.; H. Davies & Co., meters, £860; E. W[illegible] & Head, meters, £67.

Appointments Vacant and Filled.

A commercial assistant is required in the electrical engineer's department of the County Borough of Stoke-on-Trent. Salary £220 per annum. Particulars of duties, &c., from the Borough Electrical Engineer, St. Peter's-chambers, Glebe-street, Stoke-on-Trent. *See advertisement.*

A test-room superintendent is required for a Corporation electricity department in the north of England. Salary £225 per annum. *See an advertisement.*

A power-house superintendent is required for a Corporation electricisn department in the north of England. Salary £350 per annum *See an advertisement.*

A senior switchboard attendant is required for a large power house. *See advertisement.*

A draughtsman is required, preferably with experience of electrical control gear. *See advertisement.*

Three turbine fitter-drivers are required for an electric power station in large Government controlled factory. *See advertisement.*

Barrow-in-Furness Education Authority invite applications for the position of Principal of their Technical School. Salary £400 per annum. Particulars from the Director of Education, to whom applications by Feb. 18.

A senior lecturer in electrical engineering is required for the Portsmouth Municipal College. Salary £200, rising to £250 by £10 annual increments. A workshop instructor in electrical engineering is also required at the College. Forms of application from the Secretary, Mr. H. E. Curtis.

Mr. J. S. Hollingrake, of Ormskirk, has been appointed engineer-in-charge of the electricity department of Alloa Town Council.

Business Items.

Plant for Sale.—Barrow-in-Furness Corporation advertise for sale a 500 kw. d.c. steam generator and a switchboard. Further particulars may be obtained from the electrical engineer, Mr. H. R. Burnett.

Terminal Boxes.—Two new lists (U.E. 0201 and U.E. 0106 Fr.) have just been issued by Messrs. W. T. Henley's Telegraph Works Co. (Ltd.), Blomfield House, London Wall, E.C. 2.

The former gives particulars, including dimensions and prices, of vertical terminal boxes of the indoor wall type, and the latter, which is in French, gives full details of a new range of straight-through and branch boxes for all pressures up to 24,000 volts. A Spanish edition will be ready in a few weeks' time.

Companies' Meetings and Reports.

DUBLIN UNITED TRAMWAYS CO. (1896) (LTD.).—The report for the year 1917 states that the amount available for division is £96,236. Interim dividends, amounting to £23,400 were paid in August, leaving £72,836. It is recommended that a dividend at rate of 6 per cent. per annum (less tax) be paid on the preference shares for the half year ended Dec. 31, and that a final dividend at rate of 5 per cent. per annum (less tax) be paid on the ordinary shares for the same half year; that £15,000 be set aside towards renewal of rails, £7,000 be added to general reserve, and £11,000 be written off price of investments. The dividends and sums set aside absorb £82,775, leaving £13,461 to be carried forward.

EAST LONDON RAILWAY CO.—Lord Claud Hamilton, who presided over the meeting last week, said that Government control had placed them in a very cruel position, and he detailed the negotiations leading up to some correspondence between Mr. Bonar Law and himself. In a letter to the Chancellor he had pointed out that, [illegible] application of the rules governing Government control not only did the East London obtain no benefit from its electrification, but it was directly penalised on its capital, and a heavy debt against the East London was being gradually accumulated in respect of the [illegible] it had to pay to the [illegible]. He [illegible] that the Treasury had made no allowance for the [illegible] of the [illegible] which were not [illegible] and when he asked the Government [illegible] some point of view [illegible] was to make the East London [illegible] equivalent at least to the [illegible] date and [illegible]. Mr. Bonar Law wrote that the [illegible] with the [illegible] the lines and [illegible] the [illegible] to the [illegible] stopped. The [illegible] the [illegible] of the East London [illegible] the [illegible] of the East London [illegible] Executive Committee [illegible]

allowance of interest for three months on the cost of the electrification works brought into use on March 31, 1913, and he (Mr. Bonar Law) could not see how the Government could make the lessee companies a greater allowance without opening the door to similar applications from many other railway companies. The claim of the East London Railway was one for indirect loss consequent on the Government taking control of the railways, but the Government had been compelled to make a very firm stand during the war against claims of that nature. In these circumstances he feared that he was unable to make the concession suggested.

In reply to a question, the Chairman said that no precise date had been given to the larger railway companies as to when Government control would cease after the termination of the war. It was certain, however, that Government control would continue some time after the war had terminated, as many adjustments would have to be made.

METROPOLITAN RAILWAY CO.—The gross receipts for 1917 were £1,166,414 (against £1,102,346), and the total net income was £610,682 (against £609,126). Interest, rentals and other fixed charges, and appropriation to renewal absorb £305,314, dividends on preference stocks £239,107, leaving a balance available for dividend on the ordinary stock of £80,753 (against £79,145). The directors recommend a dividend at the rate of £1 per cent. per annum for the half-year ended Dec. 31, making £1 per cent. for the year, leaving £16,101 to be carried forward. The amount transferred to general renewals fund is £20,000, compared with £20,000 in 1916. The dividends paid on the ordinary stock for 1916 amounted to £1 per cent., and a balance of £14,492 was carried forward.

YORKSHIRE ELECTRIC POWER CO.—The net profit for the year ended Dec. 31 last, after payment of mortgage and other interest, was £33,258 against £29,112 in 1916 and £21,209 in 1915), and with balance brought forward (3,866) the total is £37,124. 10s. 5d. The directors recommend payment of a dividend for 1917 (less tax) at the rate of 6 per cent. per annum on the preference shares, amounting to £10,493. 14s., and 5 per cent. on the ordinary shares, absorbing £10,239. 4s. 6d., and also the transfer to general reserve fund of £12,000, leaving £4,391. 11s. 11d. to carry forward. The company continues to make substantial progress, and the directors have much satisfaction in recommending a dividend on the ordinary shares at the rate of 5 per cent. for the year, against 3 per cent. paid for 1916. During the year there have again been material increases in the cost of labour and supplies. In November last a turbo-alternator of 6,000 kw. capacity was put on load, and an additional machine of the same output is being erected. To meet the cost thereof, and of considerable extensions to the plant and mains in the southern portion of the area of supply, the Ministry of Munitions have agreed (in addition to the £60,000 mentioned in the last report) to lend to the company further amounts not exceeding £122,000, which will be secured on the plant and mains so erected. Agreements have been made to give a bulk supply to the Spenborough and Elland Urban District Councils, and to Electrical Distribution of Yorkshire (Ltd.) for supply in the Urban districts of Featherstone, Garforth, Horbury, Otley, Penistone, Rawdon, Selby and District, and Stanley. Supply to these undertakings of the Distribution Company will not be commenced until after the war.

The demands for electrical energy have been heavy during the past year, and large developments in various parts of the company's area are being made which will call for further supply. To enable these developments to be dealt with, the directors have secured a site at Ferrybridge, near Knottingley, on which to erect a generating station with large units of plant. Since the outbreak of war 98 members of the staff have joined H.M. Forces, of whom eight have laid down their lives for their country. Major George Herbert Pearce, J.P., has accepted a seat on the board.

City Notes.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.) — During the five [illegible] Nov. 30, 1917, 2,479,429 [illegible] were sold to consumers, [illegible] 2,360,[illegible] the corresponding five weeks of 1916.

CITY OF BUENOS AYRES TRAMWAYS (1904) (LTD.)—The directors [illegible] for the year 1917, [illegible] carried forward.

MARCONI WIRELESS TELEGRAPH CO. OF AMERICA (LTD.)—A pre- [illegible] 1917 [illegible]

RICHARDSONS, WESTGARTH & CO. (LTD.)—At an extraordinary [illegible] decided to [illegible]

TOTTENHAM DISTRICT LIGHT, HEAT & POWER CO.—For the half [illegible]

WESTMINSTER ELECTRIC SUPPLY CORPN. (LTD.)—The directors [illegible] 1916.

The Round Table.

By "kVA."

The man who in these days repeatedly says "I'm fed up," is either a liar, or, if he speaks truthfully, he ought to be reported to Lord Rhondda !

* * * *

Camouflage ! What a wealth of electrical meaning there can be in this pretty little word ! Think it out and make a note of the many ways in which it might be used ; in manufacturing (perhaps), in selling and factoring (especially), in wiring and cable laying (certainly), in publishing (hardly ever !).

* * * *

Speaking of camouflage, I am reminded of a suggestion that a friend recently made to me that the gas bag motor might easily be a good example of the gentle art. A little air pump on the engine keeps the bag partly inflated and maintains the impression that the car is running on gas ; all the while its wiley owner is using petrol !

* * * *

Many moons ago I recorded a case of a noisy turbo-alternator in a certain company power house in the industrial North. For several years this machine made the night hideous with her shrill hum, and on one awesome occasion her drone was mistaken for approaching enemy aircraft. The local residents never forgave her for that, and she seems since to have gone into a decline from which she has never recovered. A week or two ago she was superseded ; but she was determined to have the last word ; her rotor fell out of the slings as she was being hustled out of the power house !

* * * *

For several weeks I have been making notes of the protective methods, electrical and otherwise, which it is reported the authorities are using against enemy aircraft. "The Star" saves me the trouble of putting these into shape, and I reproduce a few of them on account of their practicability :—

"As soon as the Gothas are known to be on the way, picked men armed with powerful magnets are told off to climb up the searchlight beams and jigger up the enemy's compasses. It was an unfortunate accident to one of these men that brought this secret to light. While sitting on top of his beam, on his beam end, as it were, the searchlight suddenly went out, and the man fell. Walker is his name, and he has the bruises to this day.

"Another method is to send up British aeroplanes towing behind them great painted canvases, skyscapes showing heavy clouds and forked lightning. At the same time other planes throw overboard huge quantities of torn paper to simulate snowstorms. Hence the paper shortage.

"Then there is the wireless business. You've heard of that, of course. Every Gotha is fitted with a wireless installation, and as soon as they are within range, our men send out messages ordering sauerkraut, leberwurst, and Wiener schnitzel for supper. This makes the Germans' mouths water, and the moisture, acting on their carburetters . . . ."

* * * *

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, Feb. 5, 1881.]

TIME SIGNALS IN FRANCE.—We learn that noon is to be signalled, in country towns as well as in Paris, from the Observatory. This will be a great boon to the public.

CAUTIOUS OFFICIALISM.—From Switzerland we hear that "the Municipality of Zurich have refused permission for the placing of telephone wires on the public buildings of the city, on the ground that their tenuity renders them attractors of lightning, and, therefore, dangerous."

THE SCARE STILL.—At a recent meeting of the Mansfield Improvement Commissioners, having under consideration tenders for the erection of a new gas holder at the gasworks, several members spoke of the desirability of not proceeding too fast with the erection of expensive additions, as the electric light would probably soon supersede gas.

COMBETTE'S ELECTRIC CANDLE.—This, another ingenious pipe lighter, is composed of bichromate of potash battery enclosed in a hermetically sealed bottle, the two poles of the battery being connected with a very thin platinum spiral placed above the candle. To light it, it is only necessary to tilt the bottle, when the battery becomes active and heat the spiral.

THE ELECTRICIAN:

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CONTENTS.

Notes.

The National Union of Scientific Workers.

In our correspondence columns we publish a letter from Mr. NORMAN R. CAMPBELL, the general secretary of the National Union of Scientific Workers. By way of introduction we may say that Mr. CAMPBELL is well known in the scientific world and therefore he can look upon matters of this kind from the scientific point of view. With regard to the proposed union we do not feel convinced that it can attain its objects, or that such a union, on the lines laid down is necessarily desirable. From a pamphlet which has just been issued, we conclude that it is desired to enrol all scientific workers, but that no attempt is being made to attract those who are generally regarded as the leaders of various branches of science. It is rather an appeal merely to the rank and file. Among the objects of the union are the seeking of representation on public committees, and on Joint Industrial Councils, the establishing of a universal pension scheme, the issuing of a journal to render the conditions of scientific work more uniform, the unifying and improving of scientific education, the conduct of educational propaganda and the setting up of a permanent committee to propose, support or oppose new legislation. In looking over these objects one sees that they may be divided into two classes, namely, those which concern the powers that be, who are responsible for solving problems of reconstruction, and those which concern the recognition of the value of scientific workers by the employer. To the former belong such questions as representation on public committees and on Joint Industrial Councils, and schemes for improving scientific education. Progress of this kind can only be brought about by educating the [illegible] and it is generally recognised that [illegible] Members of Parliament and Cabinet Ministers can only be [illegible] [illegible] lack of appreciation of science [illegible] and through the [illegible] of science. [illegible] brought about by a [illegible] would have to be far stronger [illegible] than is likely to be the case with the Union of Scientific Workers. When, however, it comes to a question of other objects, such as a universal pension scheme and the "economic interests" of the members, as mentioned in the pamphlet, then no doubt something can be done by a union on trade union lines if it is sufficiently strong. We confess, however, that we are not enamoured of trade union methods for such a purpose, and we are inclined to doubt whether the National Union of Scientific Workers can attain the necessary strength to achieve all the objects mentioned. Being in sympathy with these objects, we would urge the desirability of not relying merely on [illegible] strength.

Examinations and the Board of Education.

THE Board of Education has decided, after [illegible] consultation, to discontinue its general examinations in science and technology altogether after 1918. With certain exceptions the higher general examinations will be held as usual this year. But for the fact that there are practically no students this decision would be calamitous. At the same tine we are of the opinion that it would have been better for the Board not to have discouraged students sitting for the examinations as they did discourage 10 or 12 years ago. These examinations were an incentive to students, and many of the latter were encouraged to prepare for the Whitworth competitions, national scholarships and the like. This preparation necessitated a course of study at least as thorough as that required to secure a pass degree at one of the universities. Furthermore it should be noted that it was these examinations that brought to light many promising engineers, men whose names are household words to-day. The decision to discontinue the examinations 10 years after the examinations were, to all intents and purposes, abandoned, is not without its humorous side, but the effect has been disastrous on those who during the past 10 or 12 years have been compelled to acquire their technical training at our evening schools. Most teachers who have worked under both sets of conditions will agree that the Board of Education certificate was a better inducement for young men and women to attend technical schools than were the certificates granted by the local education authority and endorsed by the Board. If we rightly understand the matter it will be virtually impossible under the new conditions for engineering apprentices to sit for the above-mentioned competitions.

The 12½ Per Cent. Bonus

THERE has been much trouble since the award of the 12½ per cent. war bonus was given to skilled men owing to the difficulty of saying just where the award should end and where the unskilled men begin. In the case of [illegible] works the position has been [illegible]. Here we have a number of skilled men in connection with the purely engineering side of the undertaking. [illegible]

think any uniform decision has been reached on this question, but we understand that the Bristol Electricity Committee have decided to interpret the word "technical" in a broad sense and to apply the award to all enployees of both sexes, whether engaged on generation, distribution, office work or management, and who are in receipt of wages or salaries not exceeding £250 per annum. We think it would be well if this interpretation were followed by other electricity supply undertakings. The case is set out at some length by a correspondent in another column, to which we would refer our readers. Employees who carry out accountancy, clerical and similar work in these days often find themselves at a considerable disadvantage owing to the fact that they have no union on which to fall back, and thus it happens that they have to meet the increased cost of living on comparatively small salaries which remain fixed. This not only gives rise to difficulty but also to discontent, and it would be well to [illegible] as far as possible.

Output and Hours of Work.

The discussion on the relation between hours of work and output, as exemplified by experiences in munition work, and illustrated especially in the data presented in the bulletins of the Committee on the Health of Munition Workers, has led to the impression that the subject is new. This, however, is not the case. The matter had been surveyed by the late F. W. TAYLOR and others in the United States, and it is, perhaps, not generally known that experiments were conducted at a much earlier date in this country. In an article in the current number of the "Contemporary Review," Lord HENRY BENTINCK mentions an inquiry made for the second Children's Employment Commission by Mr. J. L. KENNEDY in 1843. The inquiry related to the cloth print works in Lancashire, Cheshire and Derbyshire. One firm tried to run its mills 15 hours a day; by the fourth month after the change the spoiled work had doubled, and production had fallen off by 10 per cent. in spite of the increased hours. A reduction of hours had a beneficial result in restoring the old standard of work. In 1893 an experiment undertaken by the Salford Iron Works, Manchester, showed that when the week's work was diminished from 54 to 48 hours the total production [illegible] the lost time diminished from 2·46 to 0·46 per cent. In 1894 the hours of labour of about 43,000 people in Government factories and workshops was reduced to an average of 48 hours and in 1905, after trying the experiment for 11 years, the War Office gave a summary of the results, which were entirely favourable. The Admiralty, in the same year, reported equally favourable experience. In the face of [illegible] after the outbreak of war the hours of [illegible] have been extended to a [illegible] the inquiries of the Health of Munition Workers Committee proved to be highly prejudicial. The incident only [illegible]

[illegible]

Linking-Up in the Dublin District.—An interim report has been issued by a committee appointed to consider the linking-up of power stations in and around Dublin, and to report to the Board of Trade Committee upon the subject. We hope to deal with the report in our next issue.

"The Central."—ERRATUM.—We much regret that an error appeared in our note last week. Reference was made to Sec.-Lieut. E. T. Boyes and Sec.-Lieut. T. J. Hornblower as being among those who had fallen at the front. We are glad to say that there is still good news of both these officers.

American Potash.—According to the "Journal" of the Royal Society of Arts, the production of potash in the United States was greatly increased during 1916, being equivalent to about 10,000 short tons of pure potash, valued at $3,500,000, and 10 times that turned out in the previous year. It is anticipated that there will be a further substantial increase during 1917. Among the sources mentioned are the treatment of natural salts and brine, alunite and silicate rocks, and organic materials such as kelp, pearlash and miscellaneous industrial wastes. The largest output comes from the Nebraska lakes, but the natural saline deposits are now becoming more important. Speaking generally, the production derived from organic sources is about half that from mineral materials.

University of Leeds.—We have received a copy of the annual report issued by Mr. J. W. Cobb, Livesey Professor of the Department of Coal Gas and Fuel Industries at Leeds University. A summary is given of the lectures delivered on such subjects as "The Scientific Utilisation of Fuel," "Temperature Measurements in Clay Works Practice," and "The Washing of Town Gas with Oil and Tar." Research work on ventilation has been undertaken by the Department for several years, but at present is necessarily suspended. Dr. S. F. Dubbon is undertaking an investigation on the breakdown of toluene, benzine and allied compounds. The volume of work on the inspection of high explosives has considerably increased. A new post, that of Lecturer in Gas Chemistry, has been created and accepted by Mr. H. J. Hodsman, M.Sc., and it has also been resolved to appoint a Research Assistant and Lecturer on Refractory Materials.

Diesel Engine Users' Association.—The first meeting of the Diesel Engine Users' Association since the election of its new president, Mr. Napier Prentice, was held on Jan. 31. Recent communications with the Controller of Munitions Mineral Oil Production regarding fuel oil supplies and the use of tar oil as fuel in Diesel engines were reported. The Controller has appointed a Committee on these subjects, especially in connection with applications for licences to use tar oil, and of methods to adapt Diesel engines for the use of tar oil. This Committee consists of nine members of the Association, two additional members to be nominated by the Institution of Electrical Engineers, and is to be styled the Heavy Oil Engine Fuel Committee. The hon. secretary of the new Committee is Mr. Percy Still, M.I.E.E., and the offices are at 19, Cadogan-gardens, S.W. 3. Some notes were read by Mr. John Milton, giving the results of his experience in the use of tar oil as fuel in Willans Diesel engines without pilot ignition apparatus.

Electric Welding for Marine Engine Repair.—A Paper by Mr. [illegible] Jessop in the "Journal" of the American Society of Naval Engineers, describes the application of electric welding to the repair of castings of marine engines. Immediately after the declaration of war by the United States, the Shipping Board adopted electric welding as the most expeditious method of repairing the interned German and Austrian vessels at the port of New York. Fifteen such ships have been treated, and will probably shortly be ready for service. It is remarked that in welding with the electric arc complete control of the [illegible] is essential. The arc must be directed along the line of fracture, and in welding cast iron parts special alloy steel wire is used as the intermediary. It is difficult otherwise to weld two pieces of cast iron together, but it is comparatively easy to weld steel to cast iron. Electric welding is believed to have a great future in marine engineering, and it is stated that in all the work executed by electric welding in the author's experience there has never been a failure.

Effects of Heat on Celluloid and Similar Materials.—A new publication on the above subject has been issued by the Bureau of Standards, from whom copies can be obtained on application. The paper comprises a study of the behaviour of celluloid, and of pyroxylin plastics in general, when heated to different temperatures commence in the neighbourhood of 100°C. Above this temperature the heat of decomposition may raise the temperature of the mass to the ignition point, and at 170°C. decomposition takes place with explosive violence. Pyroxylin plastics can be ignited by momentary contact with bodies having a temperature of 430°C. and upward. The rate of combustion is 5 to 10 times that of poplar, pine or paper under the same conditions. The vapours evolved during the decomposition of pyroxylin plastics are poisonous and extremely combustible, and may be ignited by the heat of decomposition. A copy of the Paper can be obtained on application to the Bureau.

Water Power in Great Britain.—An interesting point is raised in a letter by Mr. Alph. Steiger to the "Journal" of the Royal Society of Arts, with reference to the recent Paper by Mr. Alexander Newlands before that body on "Water Power in Great Britain." It has sometimes been argued that the sources of water-power in the United Kingdom are of little value, owing to the irregularity of supply. The fact that such power may have to be supplemented by steam plant during part of the year, is not, Mr. Steiger suggests, a very great drawback, as this auxiliary plant would form only a small part of the total capital outlay. Even at Niagara steam power has been added, and an absolutely constant power can hardly be found anywhere. What is needed, however, is a proper record of the gaugings of rivers similar to that undertaken by the Swiss Government for years, and not merely data on annual rainfall. It is interesting to note that in Westphalia, the centre of the German coal industry, whole valleys have been closed by dams forming artificial lakes, for the threefold purpose of regulating the flow of water for navigation of rivers, to prevent flooding, and to obtain power.

Mining Institute of Scotland.—At the general meeting of the Institute at Edinburgh on Saturday, Mr. R. W. Dron, of Glasgow, read a Paper on "The Occurrence of Coking Coal in Scotland."

In the course of his Paper Mr. Dron pointed out that the question of fuel supply was even of more importance than the supply of ore. The available quantity of suitable splint coal was becoming exhausted, and furnaces would then be dependent upon splint coal of secondary quality. Whether furnaces could be adapted to the use of the coal which might be available or to the use of coke was a question which the metallurgist must consider in the light of future possibilities as to the supply of coal and coke. In nearly all the other iron-producing districts the furnaces had been designed for the use of coke. [illegible]

An Automatic Hydro-Electric Plant.—[illegible]

supplied to each generator a fixed value at all times, thus eliminating voltage regulators. This device also makes it possible to take full advantage of the full capacity of the river and improve the power factor of the system through the operation of underloaded over-excited machines. No oil governors are used for any of the machines, the gates being operated by motors, under automatic control at the hydroelectric station or remotely controlled from the steam station.

Rontgen Society.—At the meeting of the Society, held on Feb. 5, Dr. Batten read a Paper on "A Simple Means of Obtaining Static Currents from an Induction Coil." The method consists in connecting one secondary pole of the coil to earth, whilst the other is connected through a series spark gap, oscilloscope tube and a series condenser to the patient, who is placed on an insulated stand. The function of the condenser would appear to be that of a high resistance. The advantages of the apparatus are twofold. In the first place, it overcomes the troubles due to a wet climate, from which the static machine always suffers, and, secondly, it affords an inexpensive means, to those already possessing an induction coil, of obtaining currents similar to those produced by static machines. Mr. E. E. Burnside read a Paper describing a new mobile Snook apparatus. This is constructed on the same principle as the larger pattern hitherto in use, but is made in a more compact form by reducing the maximum spark gap to 7 in. Mr. Burnside also showed a small transformer constructed for employing the continuous current main supply to heat the spiral of the Coolidge tube. A small rotary converter changes the direct current into alternating current, which is stepped down to 12 volts by the static transformer. The secondary is well insulated from the rest of the apparatus, and regulation of the filament current is obtained by a variable choke-coil in the primary circuit of the transformer.

Arrangements for the Week.

FRIDAY, Feb. 15th (to-day).

INSTITUTION OF MECHANICAL ENGINEERS.

6 p.m. At the Institution of Civil Engineers, Gt. George-street, London, S.W. Papers on "Traction on Bad Roads or Land," by Mr. L. A. Legros, and "Utility of Motor Tractors for Tillage Purposes," by Mr. A. Amos.

ELECTRICAL HARMONIC SOCIETY.

6.15 p.m. At the Holborn Restaurant, London, W.C. Concert. Ladies' Night.

SATURDAY, Feb. 16th.

ROYAL INSTITUTION.

3 p.m. At 21, Albemarle-street, London, W. 1. [illegible] O.M., F.R.S.

[illegible]

MONDAY, Feb. 18th.

[illegible]

WEDNESDAY, Feb. 20th.

[illegible]

THURSDAY, Feb. 21st.

[illegible]

FRIDAY, [illegible]

[illegible]

Notes on Welding Systems.*

By Captain JAMES CALDWELL, R.E.

Summary.—The author gives a résumé of the chief methods of welding, including ordinary smith's welding, and methods based on blowpipe, thermite and electrical (resistance and arc) methods. Finally a brief description is given of suitable electrical plant for the purpose, and methods of distribution.

The art of welding is as old as the use of wrought iron: indeed, until quite recent times iron and steel were the only metals which were fire welded in practice.

Welding strictly is the art of uniting parts of similar metal by pressure at a temperature short of the fusing point, and to-day a broader interpretation must be accepted. The modern extension of the term welding to other than the ferrous metals includes processes which are in the nature of autogenous soldering. Practically the distinction between the two processes has disappeared.

Pure smith welding, the original method, the only one practical until recently, and then only on wrought iron and steel, consists in heating the parts to a temperature at which they are plastic, bringing together the surfaces to be united and applying pressure by hammering or equivalent means.

The cleanliness of the surface is secured by putting thereon some substance which will fuse, thus protecting the metal from oxidation, but which must subsequently be removed.

Such welding is dependent upon the skill and conscientiousness of the operator. Even a good operator cannot be certain that every weld he makes is a good one. Smithy welding is restricted to comparatively simple shapes, and to articles of comparatively small cross-section, except certain special cases where welding is or was performed under steam hammers, *e.g.*, the manufacture of iron guns.

RESISTANCE WELDING.

Resistance welding is a form of electric welding which is the closest approach to original smith welding. The surfaces to be united are approximately fitted, brought into close contact, and an electric current passed of sufficient strength to bring the surfaces to welding heat. Then pressure is applied to force them into contact and to extrude oxide, &c., as far as possible. The heat produced by the passage of the current is greater at the contact surfaces than in the solid metal. The heat is further localised by using clamping electrodes of low resistance which hold the work as nearly as possible to the weld. Owing to the rapidity of the heating and the very small amount of air between the opposed surfaces, very little oxidation can occur. The earliest resistance welding was performed on iron and steel, but it was also found that other metals could be welded together. For resistance welding alternating current is always used to provide the necessary large current at a low voltage, which is most economically supplied from a transformer adjacent to the welding tool. The several methods of resistance welding are referred to hereunder:—

1. *Butt Welding.*—This method is applicable to the welding of rods, bars, &c., transverse to the length of the pieces.

2. *Spot Welding* is most commonly adopted in this country to unite sheets or thin plates where a continuous weld or joint is not required. The two sheets are placed between electrode clamps which press them together, current is then switched on, the surfaces in contact brought up to welding heat, and the pressure maintained after current is off until sufficient cooling occurs. The sheets are then moved on to the next spot to be welded, and the operation repeated. Work so welded is therefore united by a line of small welds and may be compared to flush riveted work.

3. *Seam Welding* is an extension of spot welding, applicable to [illegible] thin sheets. The electrodes are rollers through which the two sheets are passed when current is applied and the [illegible]. The [illegible] current heat up the sheet to welding [illegible] as they pass between the rollers, and they are thus united along the [illegible] of the roller path. The continuous seam joint is [illegible] than spot welding, [illegible] and is comparatively [illegible] [illegible].

[illegible]

[illegible]

[illegible]

Water Gas.—This is a development of fire or smith welding, and has been largely used for making large tubes. The gas, being composed of a mixture of hydrogen and carbon monoxide produced by passing steam over red hot coke, is comparatively cheap, and when burnt with oxygen or air gives a very clean flame. By means of a blowpipe or combination of tuyeres, the edges to be joined are raised to a welding heat, and the weld completed by following up this heating with rollers or a pneumatic hammer. The system is obviously suitable for long welds, such as tubes and shells, in place of fire heating. Water gas is also used in blowpipes for fusion processes.

FUSION WELDING.

In the fusion method the edges or surfaces of the pieces to be joined are raised to fusing point. Very generally fused metal is added of composition similar to the work, so that new and old metal are amalgamated to an approximately homogeneous mass. Both flame and electric methods of heating are employed. Fusion welding should properly be classed as autogenous soldering.

(*a*) *Flame Blowpipe.*—All the flame blowpipes in practical use consist of arrangements for producing a jet of flame of regular form and size and directing it upon the work. These arrangements include means for regulating the proportions of a combustible gas and oxygen (or air), mixing the two gases and projecting them as a flame upon the work to be heated.

For welding, the flame and products of combustion in contact with the heated metal should have a chemical reducing or neutral character.

1. *Oxy-Acetylene.*—By far the most extensively used welding blowpipe method is oxy-acetylene. Acetylene and oxygen in equal volumes (in practice a little more oxygen than acetylene is always used) produce a flame with an inner core which has a temperature of about 4,000° F. This core is white, and consists of hydrogen and carbon monoxide, both of which are reducing gases.

Generally the oxygen is supplied in cylinders in a highly compressed form (120 atmospheres) and, after passing through a governor which keep the pressure constant, it provides the mechanical energy for the mixing of the gases, and the projection of the flame. The blowpipe is a form of ejector, the oxygen pressure providing the propulsive force.

Dissolved acetylene has the advantage of purity, whereas acetylene as locally generated always contains impurities of which sulphuretted and phosphoretted hydrogen are the most objectionable. A purifier capable of removing these impurities is therefore necessary for good welding.

2. *Oxy-Hydrogen.*—The oxy-hydrogen blowpipe is over a century old, but it has only been applied to welding on a large scale since 1901, about the same time that oxy-acetylene was first used for this purpose. The best known use of the oxy-hydrogen blowpipe before that time was for producing limelight. It had, however, several important industrial applications, especially for the fusion of platinum and for laboratory work. The hydrogen process has been used for a considerable time for lead "burning" or autogenous soldering.

A disadvantage of oxy-hydrogen for welding work is that the water vapour produced by combustion oxidises some fused metals, especially iron. It is, therefore, necessary to use an excess of hydrogen over the proportion required for complete combustion in order to mitigate this oxidation, and in practice about twice the theoretical quantity of hydrogen, *i.e.*, four times the volume of oxygen, has to be used.

Nevertheless the oxy-hydrogen blowpipe has its advocates, and for work with the more fusible metals, the advantages in comfort and observation of the work may outweigh the disadvantages. Certainly it is the better for lead burning and metal cutting.

3. *Oxy-Coal Gas.*—Coal gas and oxygen produce a blowpipe flame which has considerable resemblance to the hydrogen flame. The products of complete combustion are carbon dioxide and water vapour, both of which are oxidising gases. Oxy-coal gas welding has been very little used, acetylene having proved easily superior, and [illegible] practice has not developed.

(*b*) *Thermit Welding* is a fusion process which is only applicable to the ferrous metals.

A mixture of aluminium and iron oxide (ferric oxide=Fe_2O_3) ignited, burns or deflagrates with the formation of metallic iron and alumina. The temperature of the reaction is very high, much above the melting temperature of iron and alumina. In outline the process is carried out by fixing the parts to be joined in their proper positions and surrounding them with a mould of refractory material in which the space to receive the metal coincides with the jointing line.

This process is analogous to the old method of "burning" for repairing broken cast iron articles by making a stream of molten cast iron flow over the joint, but the thermit metal is far hotter, the reaction temperature being over 5,000° F.

This welding method has been extensively applied to the jointing of tramway rails and for repair work of various kinds, for example, fractures in stern frames.

As a refractory material mould has to be made to suit the work, thermit welding is not exactly an emergency method, and there are limitations to the size of work practicable.

(c) *Carbon Arc.*—Generally known as the Bernardos System. The work is connected to the positive load and the negative electrade is a carbon rod fixed in an insulated holder. An arc is struck by touching the work with the carbon and withdrawing it to a distance varying with the current used. The pressure required is about 90 volts, and the current from 50 to 500 amperes, according to the size of the work. The carbons vary from ½ in. to 1½ in. in diameter to suit the current. A regulating resistance is used to limit the current, and closer regulation is effected by the worker's control of the length of arc.

The work should be the positive electrode as that is the hottest part of the arc, so that carbon and other impurities are removed from the iron. The temperature of the carbon arc is estimated at about 7,500° F.

The light and heat from the arc are extremely prejudicial to the unprotected eyes and skin, so that the operator must be well protected.

In one variety of carbon arc, two carbons are used inclined to each other, the arc being formed between these and projected on to the work by an electromagnet like a blowpipe flame. There is no apparent advantage in this form, and a distinct liability to the carbon being carried with the metal from the positive carbon.

The Bernardos arc has been and still is extensively used for filling blow holes in steel castings.

In making butt joints in iron or steel, the parts are abutted, and pieces of scrap of the same material are added and melted to thicken up the joint.

The carbon arc is used very successfully in the manufacture of steel oil drums, and has been so applied during the last 20 years by the Steel Barrel Co. at Uxbridge.

The carbon arc has been applied to cast iron, using a cast iron rod as filling material. The operator should aim at holding the carbon at a distance which gives a quiet steady arc. With too short an arc the metal boils and spurts, with too long an arc the arc wanders, the heat developed is partly wasted in the air and there is a liability to oxidation of the hot metal.

It does not appear that carbon arc welding is in general use for other than ferrous metals, although copper can be welded by this process. On electric tramways and railways, where current is available from a trolley wire or third rail, it is a very convenient way of cutting and boring hard steel [illegible] work, which is not amenable to ordinary tools.

(d) Metal Arc.

1. Bare Metal Electrode — Slavianoff Process.

In this process the carbon rod is replaced by a rod of metal of similar composition to that to be welded. The arc temperature with metal electrodes is considerably lower than the carbon arc, so there is less risk of burning the work.

In an arc the material of the positive electrode is carried across the arc in the form of vapour and deposited on the negative electrode. [illegible]

[illegible]

the arc. This oxide is liable to get into the weld forming flaws. The bare metal also dissipates a good deal of heat, thus wasting energy. On the other hand the arc itself is much shorter than the carbon arc for equal currents, and less energy is radiated from it.

The bare metal electrode is used considerably in the United States, where some users state that no fluxing is necessary.

Other American authorities state that the weld made without fluxing is distinctly cold and short, and requires annealing.

There is very little European experience available as to welding with bare metal electrodes.

2. Coated Metal Electrodes.

(a) *Gaseous Flux Process.*—In this process, the metal electrode is covered with a fireproof sleeve of non-conducting material, so that as the metal is removed by the arc the sleeve projects beyond the end of the rod, forming a guide for the molten welding metal, the sleeve itself falling away automatically. This sleeve also protects the metal from oxidation and reduced heat losses.

It is an improvement on the bare metal electrode, and a great deal of satisfactory work has been done with it, namely, in repairing marine boilers, stern frames and other ship parts.

(b) *Liquid Flux Process.*—In this process, invented by Strohmenger, of the Quasi-Arc Co., a sleeve or covering is applied to the material, and the material of this sleeve is such that it melts and forms a flux, covering the end of the electrode and the added metal, thus protecting both from oxidation. The flux may contain constituents having a chemical action upon the fused metal, to improve its qualities.

The viscosity of the molten slag is of importance, and various substances are used by differemt makers.

Some experiments are being made with fluxes of a "basic" character instead of "acid" silicates, presumably to reduce the amount of silicon in the metal.

In some cases the fluxing material is put on the electrode rods in a plastic condition by forcing through dies, and in other makes part of the flux constituents are placed in the form of a powder in a tubular or channel electrode.

The material of the rod can also be varied to suit the work. For example, nickel plated rods are made for the special purpose of welding high-speed tool steel into mild steel shanks.

The fluxed metal arc process is certainly of the greatest promise for constructional welding, as for example, in shipbuilding. Trials already made on full scale show that in some respects it is superior to riveting. Actual experience in ships in service is wanted to show whether these last results are borne out in practice, because no testing machine can reproduce the complete stresses endured by a ship in service. There is already good reason to say that if welding can replace riveting there will be a considerable saving in material and labour in shipbuilding. Whether an all-welded ship is practicable or not, this method of welding is satisfactory for a large number of constructional details.

The light and heat given off from the fluxed metal is much less than from the carbon arc, but screening of the face is necessary to protect the eyes from glare and sparks by tinted glass let into a light frame which is held in the hand.

Particulars of Typical Plant.

1. Self-contained.

For portable plants a petrol or oil engine has the advantages of lightness, small bulk, and requiring little attention. For stationary plants the choice of prime mover is mainly dependent upon economical considerations. If steam is available, steam engines will naturally be chosen.

The type of generator used must be determined [illegible]

2. Connection to a Generating System.

[illegible]

On the relatively high voltages prevailing (200–250 v.) it is necessary to use a motor generator set, *i.e.*, a 100/110 volt dynamo driven by a motor fed from the general supply; or a reducer set may be employed comprising two motors of 100/110 volts connected in series, with the welding current taken from the terminals of one machine. The losses by such conversion should not exceed 20 per cent. of the energy actually used by the welders if the use is reasonably continuous. If the welding current is taken direct from a three-wire system the supply should only be taken from the "middle" to one "outer" conductor when carbon arc welding is intended, the work, of course, being connected to the middle wire, which should be positive and earthed.

With the metal arc this observation does not apply to the same extent, as it is then not so important to insist on the earthed work being negative which would be the correct connection in that case.

For resistance welding from direct current supply, a motor generator must be used, the generator giving an alternating single-phase current. The supply pressure is not important.

(*b*) *Alternating Current.*—Single-phase 100 volt supply can be connected direct through suitable resistances to arc welders; with higher pressures transformers are necessary. For resistance welding the pressure is not material, each welder having its own transformer producing a pressure necessarily much lower than the supply value.

On a three-wire two-phase system, single-phase pressure may be taken from the two outers, and suitably reduced.

Alternatively, each welder may be connected to one outer and the inner conductor (or to two single-phase transformers so connected if the supply pressure is not suitable for direct use) exactly as in the case of a three-wire continuous current system. Supply authorities object to seriously unbalanced loads on either two or three-phase systems, and if the welding installation is of considerable size relatively to the general load in the neighbourhood such an arrangement may not be permitted.

It is not quite so simple to obtain a single-phase current from a three-phase supply as from a two-phase, inasmuch as a transformer must be used with its secondary windings connected up in a particular way. This connection gives currents largely out of phase in opposite senses in two of the phases which is objectionable both from the production of out of balance voltage and the lower power resulting.

On a three-phase system, welders can also be connected to the separate phases, each of which yields a single-phase current, but the objection to unbalanced loads has to be met, and this method is not to be recommended, unless the number and constancy of use of the welders ensures a fair balance between phases.

Before deciding to utilise public supplies on either the two or three-phase systems for welding installations of any magnitude, it is wise to consult the supply authorities and obtain their assent to the connections.

Distribution Methods.—Circuits independent of lighting and motor circuits should be used for supplying welders. The conductors must be sufficiently liberal in size to ensure full voltage at the farthest point when all the welders are in use. The fuses on the mains must be heavy enough to carry the maximum working current of all the welders likely to be in simultaneous use. The larger the number of welders the more nearly will this approximate to the total average current.

The flexible leads to electrode holders require some attention. The conductors should be of fine wire strands, sufficient length and arrangement of fittings made to permit freedom of movement without liability to kinks, and the cable protected with tough durable material, such as "cab tyre" sheathing. In the case of carbon arcs, the last foot or two may be protected from the heat of the arc by an asbestos covering.

When power supply is small compared with the current required for welding it is usual to employ a substitution resistance and some automatic device to put this resistance into circuit when the arc is broken.

With any form of welding manipulative skill must be acquired.

Repair work, involving great variations in problems presented required skilled operators; repetition work is naturally much easier.

Electric Drive for Cotton Mills.*

By J. E. MELLETT.

(*Concluded from p. 658.*)

[illegible] cotton mills, and states that in practically every case the electric [illegible] the lowest operating costs, highest quality of product, and greatest [illegible] general of electric driving, and gives detailed consideration to the [illegible] to the various machines and operations involved.

[illegible]

[illegible]	[illegible]	Total Price.
[illegible]	[illegible]	$1,200
[illegible]	[illegible]	1,4[illegible]
[illegible]	7,100	1,[illegible]
[illegible]	[illegible]	1,900

[illegible] conditioning 25,000 [illegible]

[illegible]

a temperature of 95°F. has installed three 3,000-watt 550-volt tubular type electric heaters, which operate from March to November, after which time steam heat is used. In circuit with the heaters, a thermostat and relay are used which automatically cuts in or out the proper number of heaters to maintain the necessary temperature.

COST OF ELECTRICAL EQUIPMENT.

The investment necessry to properly equip a mill for electric drive is dependent on a number of factors. The practice used in new mills is to install individual motors for each machine or adopt the two or four frame drive for the spinning and lighter groups for the other departments. This method of drive is adopted in order to eliminate as far as possible all shafting, belting, &c. While this type of drive requires a greater investment for the electrical machinery than larger group drives the extra investment is offset by the larger investment for hangers, belting and shafting, and admits of a greater increase in production.

Mill Lighting.—The lighting of cotton mills involves a variety of problems, beginning at the opener room through the numerous intermediate steps to the weave shed and finishing room. The quality, quantity and cost of the product depends on the amount of spoilage, the safety, willingness, and ability of the employees to furnish the best possible returns in labour. These results cannot be attained unless the management has given the proper attention to good lighting. Proper illumination improves the efficiency of the operative, which in turn tends to eliminate "stoppages" [illegible] and time wasted in trying to do work under poor lighting conditions.

[illegible] directly due to fatigue during the latter part of the day when the operative is tired and more liable to be [illegible]. At this time of the day, light fails him and good lighting is essential. Under artificial lighting and ordinary conditions the amount

Table I.—*Electrical Installation Costs.*

Mill.	Spindles.	H.P. in. Motors Installed.	Motors Cost Per h.p.	Wiring Erecting Cost Per h.p.	Total Cost Per h.p.	Cost per Spindle.	Type of Motor Drive.
			Dols.	Dols.	Dols.	Dols.	
A	8,500	520	12·70	3·85	16·55	1·01	Group
B	14,000	600	12·85	4·35	17·20	·735	Group
C	22,000	1,330	13·53	4·96	18·49	1·12	Two and four frame, group
D	10,000	445	10·80	3·37	14·17	·63	Two and four frame, group
E	11,850	665	15·80	4·96	20·76	1·16	Individual two and four frame, group
F	40,000	1,900	9·22	4·73	13·95	·66	Two and four frame, group
G	18,700	1,550	12·25	4·50	16·75	1·37	Individual two and four frame, group
H	11,780	845	12·70	4·96	17·66	1·27	Individual two and four frame, group
I	10,560	575	11·55	4·35	15·90	·98	Individual two and four frame, group
Average	16,377	937	12·38	4·45	16·83	·965	Four frame and group

Table I. gives the cost of electrifying nine mills from and includung 1913 to July, 1916, and covers prices prevailing during that period. These figures do not include the cost of transformers or sub-stations and are based on copper averaging approximately 23 cents per pound. Present prices are somewhat higher.

Table II.—*Mill Heating Costs.*

Mill.	H.P. Motors.	Producing Spindles.	Contents mill cubic ft.	Sq. ft. Radiation.	Cu. ft. per sq. ft. rad.	Cost per h.p. per yr. dols.	Cost per yr. dols.	Product.
A	520	8,500	700,000	3,100	225	·60	312	Med. duck
B	600	14,000	790,000	3,000	260	·83	500	Hos. yarn
C	1,330	22,000	2,100,000	6,000	350	·75	1,000	Med. duck
D	445	9,800	320,000	1,610	200	·50	220	Hos. yarn
E	665	11,850	512,000	4,400	116	·75	500	Sheetings
F	650	12,700	—	—		·49·5	315	Specialties
G	560	10,560	400,000	1,900	210	·61	340	Hos. yarn
Average	681	12,787	803,666	3,335	227	·67	456	

The average price of coal at these mills is approximately $2·60 per ton.

of actual work produced is between 10 and 20 per cent. less than under daylight conditions. These facts mean a loss of production, which could be improved by better lighting. In the United States alone 500,000 avoidable accidents have occurred in one year, and it is estimated that 25 per cent. of these [illegible] were caused by indifferent illumination. Statistics show that the greatest number of accidents occur during the months of October, November, December, January and February. December being the shortest daylight month it has the [illegible] number. [illegible] one of the earliest "Safety First" movements [illegible] campaign of education for better lighting [illegible] plants.

Mill Heating.—The heating of a cotton mill must be given the proper consideration, but [illegible] item in determining the amount chargeable to heating the mill in the event that the use of central station power [illegible]. If a greater quantity of fuel than necessary is [illegible] and other processes requiring steam [illegible] balance left chargeable to [illegible] [illegible] power plant [illegible] on the engine [illegible]. The data in Table II on actual heating costs [illegible] central station power will be of interest.

Efficiency of Electric Motors.—Within recent years the efficiency of the electric motor has been gradually increasing, especially in the types used for individual drive in textile mills. [illegible] run from 80 per cent. in the fractional horse-power to 93 per cent. in the larger motors. Motor efficiency in cotton mill work depends on load conditions and the type of drive. If a mill is equipped with individual drive the ratio of the motor efficiency will [illegible] 80 per cent. With individual two and four frame drive, 88 per cent. If large motors are used the efficiency will approximate 90 per cent. The overall efficiency including transformers, lines and motors for electrical transmission can be summed up from [illegible] data and past experience as follows:—

	Per cent.
Individual drive, overall efficiency [illegible]	82
Individual, two and four frame, overall efficiency [illegible]	84
Four frame, and group, overall efficiency [illegible]	86
All group, overall efficiency [illegible]	86

The advantages to be derived from the various types of electric drive will be discussed later.

Mechanical Drive Friction Losses.—The friction losses in mechanically driven cotton mills are [illegible] from 25 to 40 per cent., the losses [illegible] depending on the type and arrangement of drive. [illegible] the best [illegible]. It is very difficult to determine the actual friction loss due to the fact that the friction at no load or light load is considerably less than under full load conditions. While the indicator card, taken with all the load off, in a measure gives a fair idea regarding the friction loss, it is not correct and does not give the true friction losses at full load. The friction losses in the average mill may be chargeable to the various sub-divisions of mechanical power transmission in consecutive order as follows: Engine, main belt on rope, head shaft, counter shaft and ultimate receiving shafts.

Table III gives the percentage of increase in production obtained and friction losses eliminated by the application of the various types under average conditions.

Table III.

[illegible]	Increase in production.	Friction losses eliminated.
	[illegible]	[illegible]
Individual drive	[illegible]	[illegible]
Individual, two and four frame	[illegible]	[illegible]
Four frame and group	[illegible]	[illegible]
All group	[illegible]	[illegible]

Advantages of Central Station Service.—The advantages of electric drive and central station service may be summarised as follows:—

Increased Production.—Lower cost per pound of goods produced.

Reduction in capital expenditure or an equivalent increase in production with the same investment. More uniform speeds at all loads, as the prime movers of the central station are larger and operate at a more constant speed.

Power supply is more reliable, as the central station has auxiliary equipment and connections with other central stations.

Freedom from the necessity to [illegible] the coal problem, strikes, [illegible] and [illegible].

Flexibility, freedom to make extensions or alterations and to operate overtime in any or all departments at a proportional or lower cost per power unit. The [illegible] cost of [illegible] [illegible] any one department [illegible].

[illegible] which is maintained during the life of the motors; expenditure on [illegible] which [illegible] depreciates in value [illegible] in efficiency.

[illegible]

Notes on the Design of Electromagnetic Machines.*

PART III.

DESIGN OF AN ALTERNATING-CURRENT TURBO-GENERATOR.

By STANLEY PARKER SMITH, D.Sc.

(*Continued from page* 662.)

Summary.—In Part I. of the article the author deals with some of the main principles underlying the design of alternating-current generators. In Part II. these principles are applied to the design of a low-speed, three-phase alternator, giving 750 kw. at 2,200 volts when running at a speed of 250 revs. per min. In Part III. a three-phase turbo-alternator is designed to give 2,000 kw. at 3,000 revs. per min. at a line pressure of 500 volts, and the mechanical stresses in the rotor are discussed.

(c) *Rotor Leakage.*—The saturation curves (4) and (5) for the rotor teeth and pole-centre respectively have been calculated under the assumption that all leakages were absent, and these curves must now be modified to allow for the effects of leakage.

In the author's Paper, mentioned above, leakage was intentionally ignored, as only ideal machines were dealt with, but in a later Paper by Mr. R. G. Jakeman † simple methods were given for taking this effect into account, and his method of treating the end-bell leakage will be made use of here.

Though the following calculations of the rotor leakage are based on an imaginary system of flux distribution, all the most important factors influencing leakage are considered.

The magnetic leakage of the non-salient pole rotor consists essentially of *slot leakage*, by which is meant the flux passing across the rotor slots in virtue of the difference of magnetic potential between their opposite faces, and the *end-bell leakage*, which is the flux passing directly from one pole to another of opposite sign through the magnetic path offered by the end-bells which enclose the overhang of the rotor winding. When the end-bells are of bronze or other non-magnetic alloy, the leakage through them is usually negligible, but in the common case of steel bells, this leakage effect is of the greatest importance.

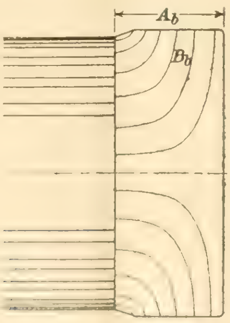

FIG. 21A.—ROTOR END-BELL LEAKAGE.

(i.) *End-bell Leakage.*—The suitable treatment of end-bell leakage is a matter of some complexity, but the simple method described by Jakeman in the Paper just referred to is sufficiently accurate for most purposes. The nature of the leakage flux in the bells is shown in Fig. 21A, and Jakeman's method is based on the assumption that the cross section of the bell is completely saturated at all excitations within the working range. Then the density B_b and the corresponding flux $B_b A_b$ are regarded as constant. Both calculation and experience [illegible] the validity of this assumption [illegible], when there is [illegible] B_b [illegible] but with [illegible] the [illegible] based the [illegible] B_b [illegible]

[illegible] to

* [illegible] Electrician [illegible]

† [illegible]

assume that the air-gap density is reduced by an amount B_λ, depending on the magnitude of leakage flux in question. This assumption is justifiable, since most of the leakage flux emerges from the upper parts of the teeth and polar horn, whilst the high densities occur near the root. In the case of the end-bell leakage, the flux passing from a pole into each end bell is $2B_b A_b$, or $4B_b A_b$ into the two bells, so that in a machine with $2p$ poles, the end-bell flux is equal to $8pB_b A_b$. Thus we have for the equivalent gap density B_λ

$$B_\lambda A_g = 8pB_b A_b,$$

so that for a two-pole machine $(p=1)$,

$$B_\lambda = 8\frac{A_b}{A_g} B_b.$$

By planimeter, we find $A_b = 66$ cm.², so that for $A_g = 20{,}200$ and $B_b = 21{,}000$, we get $B_\lambda = 550$.

From Fig. 21A it is seen that end-bell leakage influences both the region of the pole-centre and the rotor teeth, so that the two curves (4) and (5) must be corrected. To allow for bell leakage, then, the ordinates of these two curves have merely to be reduced by 550, giving curves (4′) and (5′). Thus while the actual densities in the rotor are represented by curves (4) and (5), the densities crossing the gap are reduced by end-bell leakage to curves (4′) and (5′). *See* Fig. 23A.

(ii.) *Slot Leakage.*—The effect of slot leakage is to divert flux which would otherwise pass radially up each tooth, so that the lines of induction assume an oblique direction, sloping away from the pole centre (*see* Fig. 21B). The actual distribution can thus be split up into *radial* lines passing radially along the teeth and gap, and *transverse* lines passing peripherally across the slots. The former is the system for which the saturation curves (4) and (5) were calculated, whilst the latter constitutes the slot leakage flux which must now be dealt with.

A simple mode of treatment is possible if we assume that the leakage flux crossing every slot is of the same magnitude. This assumption presupposes that there is the same difference of magnetic potential between the opposite faces of each slot, and though this is not actually true, owing to the higher saturation of some teeth than others, it appears from a more accurate investigation of the actual conditions* that the effect of the error upon the total flux is not important. Consequently, the assumption of an equal flux crossing each slot is near enough for ordinary work.

Thus the slot leakage flux, or peripheral component of the rotor flux, can be regarded as originating in the pole-centre and crossing each slot in turn without change of magnitude until it finally crosses the tooth midway between a pair of poles as in Fig. 21B. Consequently, the slot leakage only affects the pole-centre by providing a path across the slots in parallel with the path across the air-gap, so that only curve (5′) has to be corrected.

The magnitude of the slot flux evidently depends on the ampere conductors per slot and the permeance across the slot. If magnetic wedges are used—*e.g.*, cast iron—to reduce tooth ripples due to the rotor teeth, the slot leakage becomes very

* Whilst writing this article, the author has had the advantage of seeing a careful investigation by Mr. C. C. Hawkins into the actual distribution of the flux in a cylindrical rotor. This study shows that for purposes of a still closer estimate of the total flux or of the exact shape of the flux wave, a more detailed analysis than that adopted here is essential.

considerable, but with non-magnetic wedges, which are commonly used, the effect of slot leakage is usually less than that of end-bell leakage. Bronze wedges are used in the present case.

The calculation of the slot permeance is clear from a reference to Fig. 21B. For the wound part of the slot the specific permeance is r_2/r_1, but since the leakage paths of this part are acted upon only by one half of the ampere-conductors, the

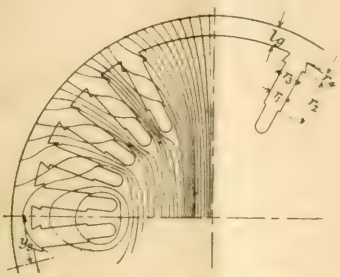

FIG. 21B.—ROTOR SLOT LEAKAGE.

effective permeance per centimetre length will be $r_2/2r_1$. For the wedge part of the slot, the mean width of which is $(r_1+r_3)/2$, the specific permeance is $2r_4/(r_1+r_3)$. For the permeance of the path across the tops of the teeth, it is near enough to assume the flux extends right across the gap with a mean length of path equal to the rotor slot-pitch. Thus the specific permeance of the leakage flux across the tops of the teeth will be l_g/y_s. The total slot permeance is then

$$L_i\lambda = L_i\left(\frac{r_2}{2r_1} + \frac{2r_4}{r_1+r_3} + \frac{l_g}{y_s}\right).$$

If AC denote the ampere-conductors per slot, the M.M.F. acting upon the leakage path of a slot will be $0{\cdot}4\pi AC$ and since flux leaks on either side of the pole centre, the total slot-leakage flux from each pole centre will be

$$\Phi = 2 \times 0{\cdot}4\pi AC \times L_i\lambda.$$

Calculating λ for the present machine, we have:—

$$\lambda = \frac{9{\cdot}0}{2 \times 2{\cdot}8} + \frac{2 \times 1{\cdot}5}{2{\cdot}8 + 4{\cdot}0} + \frac{2{\cdot}0}{7{\cdot}36} = 2{\cdot}32.$$

Assuming an excitation of 25,000 ampere-turns per pole—that is, 5,000 ampere-conductors per slot—the total slot-leakage flux from each centre will be

$$\Phi = 2 \times 1{\cdot}257 \times 5{,}000 \times 100 \times 2{\cdot}32 = 2{\cdot}92 \times 10^6 \text{ lines.}$$

If B_λ denote the equivalent gap density—i.e., the amount by which the slot leakage reduces the density above the pole-centre, we have

$$\Phi = B_\lambda \frac{A_g}{S},$$

whence $B_\lambda = \dfrac{2{\cdot}92 \times 10^6}{3{,}100} = 942$ lines per cm.² for 25,000 AT pole.

Since the slot wedges are non-magnetic, B_λ will be directly proportional to AC, so that we can plot the slot leakage curve (6) as a straight line in Fig. 23A.

The saturation curve (5′) has now to be corrected for slot leakage. The ampere-turns producing slot leakage are the ampere-turns required for the pole-centre, the air-gap and the stator teeth and core. Since the ampere-turns for the stator are usually negligibly small, we need only correct curve (5′) for the ampere-turns acting on the pole-centre and the gap. This correction is made graphically, as shown in Fig. 22. To correct for the ampere-turns consumed by the pole-centre we have merely to subtract the ordinates of curve (6) directly from the ordinates of curve (5′), whence we get curve (5″). To allow for the gap ampere-turns represented by curve (1), a simple graphical construction can be used. Through any point t on the air line (1) draw the co-ordinates, and set off $a'b'$, equal to ab. Through b' draw a horizontal line to cut the curve (5″) in c; then $cd = a'b' = ab$, so that d will be a point on the curve finally corrected for slot leakage. By taking t at different positions along curve (1), this construction gives us further points on the final curve (5‴), which now represents the saturation curve for the pole-centre, corrected for both end-bell and slot leakage.

To show that the curve (5‴) reduces the curve (5′) by the proper amount, it is only necessary to add the abscissæ of curves (1) and (5‴) to give curve (1+5‴), and draw the co-ordinates through any point on the latter. It is then seen that the difference de between the ordinates of curves (5′) and (5‴) is equal to the ordinate $d'e'$ of curve (6).

The final magnetisation curves for the wound and unwound parts of the rotor can now be found straightaway. To get curve (7), $B_g = f(AT)$ for the pole-centre and stator teeth, we add the abscissæ of curves (1), (3) and (5‴); and to obtain the corresponding curve (8) for the wound part of the rotor, we add the abscissæ of curves (2) and (4′). From these curves we can now find the flux per pole corresponding to any given excitation.

(d). *Determination of the Flux per Pole.*—This can be done either graphically, as shown in Fig. 23, or by the "flux per tooth" method. The latter will be easily understood after the former has been explained.

The graphical method consists in drawing a number of diagrams showing the distribution of the rotor ampere-turns at different excitations. This is shown in Fig. 23B, four such diagrams being usually sufficient in practice.

The maximum heights of the flux waves corresponding to these excitations are found by projecting the maximum value of each ampere-turn diagram on to curve (7), and the remaining points of the flux waves by projecting the other steps of the ampere-turn diagrams on to curve (8), whence we obtain the flux waves in Fig. 23C. In the actual flux wave, all corners are well rounded, but in imitating this, care must be taken that the total area of the wave is not diminished.

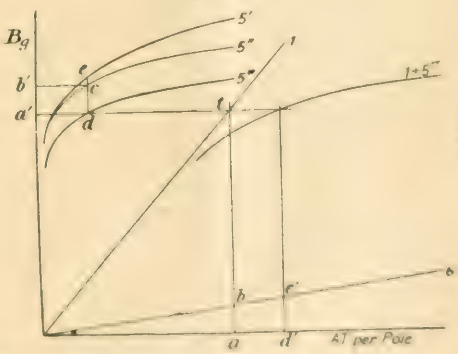

FIG. 22.—GRAPHICAL METHOD OF CORRECTING FOR ROTOR SLOT LEAKAGE.

An additional flux wave is also plotted by projecting the steps of one of the ampere-turn diagrams (in this case the lowest one) on to the air lines (1) and (2), in order to obtain the air line of the open-circuit characteristic. This flux wave is shown dotted in Fig. 23C.

To obtain the value of the mean flux density B_{mean} in the gap corresponding to the excitation chosen, the area of the flux curves in Fig. 23C is measured by means of a planimeter and divided by the base length. These values are then entered in column 4 of Table V.

The flux per pole Φ entering the stator is found by multiplying B_{mean} by the area of the gap over a pole, A_g = 10,100 cm.². Φ is entered in column [illegible] of Table V.

Table V.—*Data for Open-Circuit Characteristic when* $\beta = \frac{10}{13}$.

1	2	3	4	5	6	7
B_{mean}	Flux per pole $\Phi \times 10^{-6}$.	E.M.F. per phase E_p.	AT for teeth and gap.	AT for stator core.	AT for rotor core.	AT per pole.
3,510	35·5	226	10,000	140	160	10,300
4,740	47·9	305	15,000	280	750	16,030
5,490	55·5	353	20,000	490	3,070	23,560
6,060	61·3	390	25,000	840	6,870	32,710
(3,630)	36·7	234)	(10,000)	—	—	(10,000)

if present, could have no effect on the magnitude of the virtual E.M.F. Since $T=3$ turns per phase in series, we have

$$E_p = 4{\cdot}24 \times 50 \times 3 \times \Phi \times 10^{-8} = 6{\cdot}36\Phi \,.\, 10^{-6}.$$

At normal volts on no load ($E_p=289$) : $\Phi = 45{\cdot}5 \times 10^6$.

E_p is entered in column 3 of Table V.

In column 4 of this table appear the corresponding values of the ampere-turns per pole for which the flux curves have been drawn, and it only remains to add the ampere-turns required by the stator and rotor cores to complete the data for the open-circuit characteristic of the machine.

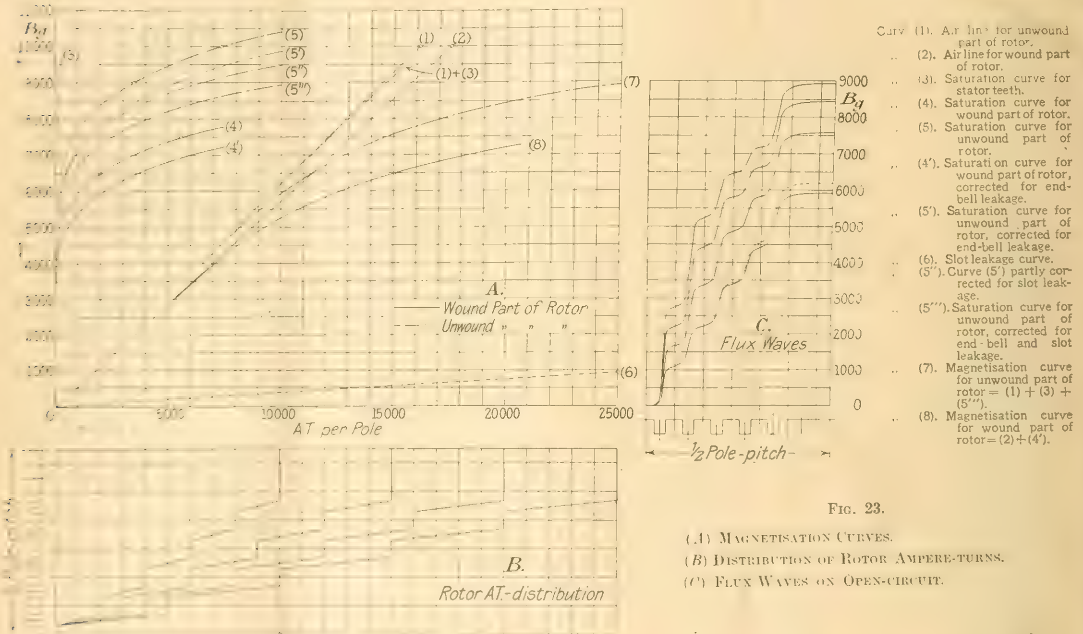

FIG. 23.

(A) MAGNETISATION CURVES.

(B) DISTRIBUTION OF ROTOR AMPERE-TURNS.

(C) FLUX WAVES ON OPEN-CIRCUIT.

The induced E.M.F. per phase can now be calculated from the equation

$$E_p = kT\Phi 10^{-8}$$

[illegible] $k = 4{\cdot}24$ [illegible] the pressure wave will [illegible] be readily seen by drawing [illegible] waves in Fig. 23c. [illegible] will not appear in the stator phase [illegible] of stator slots does [illegible] tooth ripples.

Instead of actually drawing the flux waves, as in Fig. 23c, the values of B_g for each tooth in the pole can be read off curves (7) and (8), whence B_{mean} can be found. This is known as the "flux per tooth" method. The number of teeth to be taken for the pole-centre depends on the value of β. Thus, when $\beta=10/13$, there are four teeth in the pole-centre.

A more accurate way of proceeding is to find and use the value of the fundamental in the flux waves in Fig. 23c, but this is a refinement we need not go into here.

(To be continued.)

Kelvin As a Teacher.*

By Prof. MAGNUS MACLEAN, D.Sc.

[illegible]

[illegible] usually on his right eye, his left forefinger on the name and pencil in his right hand, ready to record. In most cases the student stood speechless, as if affected with aphasia. The question was put in other forms, and no answer forthcoming, the student was peremptorily asked to say "Yes" or "No." Finally, when the puzzled youth would not venture to commit himself, there came the sarcastic, "Please say Yes," and without further waiting, the pencil descended [illegible] mark was put in the record book. I suppose students thought that the mark would be taken into account in deciding the final [illegible] for class tickets. As a matter of fact it was simply the letter [illegible] to indicate that he was orally examined, the length of the [illegible] depending on the degree of exasperation which Kelvin had reached when he asked the student to "Please say Yes."

My reasons for taking full notes of the lectures to the Higher class were (1) For my own instruction, (2) for Kelvin's help and [illegible] next lecture, as he very often wanted the last equation

* [illegible]

of the previous lecture reproduced exactly as he left it. The subjects were varied from session to session: Elasticity, Hydrodynamics, Theory of Heat, Theory of Light, Electromagnetic Induction, respectively occurring 6, 4, 3, 2, 1 times in the 16 sessions during which I was first student and then assistant.

There was no systematic course of instruction in the laboratory. A number of Thomson scholars were always engaged in experimental research, and new students were attached singly or in pairs to each scholar, and had to help in making observations and devising new apparatus. Nothing was done for them.

Kelvin was impatient about investigations set to the laboratory staff. Before the experimenter had time to arrange the apparatus he would suddenly get up from his table and green book to ask for results. He was quick in temper, as in mind. Little mishaps, or an apparent want of economy on the part of a student, often sent the great scientist into a paroxysm of passion. For example, if a student were found twisting two bare copper wires together to form a metallic junction instead of using a binding screw, he would inevitably be subjected to a severe lecture on the waste of what Lord Kelvin called "good and dear material."

Incidents of this kind stand out prominently in my own experience while assistant. It had been one of my duties, in conjunction with the mechanic, to prepare the previous afternoon all the experiments he deemed necessary for the lecture next morning. This frequently involved hours of work. But, alas! to our chagrin, next morning an unanswered question by a student in the oral examination set the lecturer off at a tangent to discuss subjects quite different from those that were to be illustrated by the experiments prepared. This was no uncommon occurrence, and, of course, very irritating to the one whose labour was wasted. I think it was towards the end of my first session that the subject of polarisation of light came up for discussion. On a table in a bay window at the south side of the class-room lay apparatus to show polarisation by reflection, including the effects seen on compressed glass as viewed by polarised light. There we had laid out strips of glass 6 in. long and ½ in. broad, which were to be bent in their own plane while being viewed through a Nicol's prism. Some students, accidentally, or through ignorance, bent them in the wrong plane and broke the strips to pieces. I suppose the shattered apparatus had been in the window for several days, when immediately after one of his lectures, Lord Kelvin came into the apparatus room with one of the short, broken pieces of glass in his hand and asked me in an angry tone what I meant by putting on the table such a specimen. In reply I inquired in an equally angry tone what he meant by bothering me about a broken bit of glass when I was busy with other urgent duties. In a few seconds, or it might be a few minutes, it would be hard to say which of us was the more speechless. It was my first and last temper tussle with him. From that time he understood that I was not to be lightly annoyed, and I, on my part, respected his impulsive disposition. Our relations became more cordial and instead of asking for dozens of experiments to be got ready for him, he would look in during the afternoon and ask what I had ready, or if I did not see him the previous afternoon I would hand him a slip of paper in the morning with a list of the experiments which were ready on the table and a heading or two announcing the subjects on which he [illegible]

[illegible]

[illegible]

[illegible]

and, to some of us, mystifying, discourse on impulse, momentum and moment of momentum. Then towards the end of the hour the assistant handed him an old Jacob's rifle. Seizing hold of this, Kelvin spent some time in getting down on one knee in front of the class, laying the rifle in wooden V grooves which had been accurately placed beforehand by the assistant, so that a bull's eye could not be missed at three yards' distance, and finally adjusting his eye-glass on his right eye. After considerable movements of this kind the gun was at last fired, accompanied by the cheering of the class of about 200 students. The assistant read 11 as being the number of centimetres the tape was drawn out by the bob of the pendulum. Substituting this number in the formula on the board we read (we could not hear) that the velocity of the bullet was 880 ft. per second. We had other very exciting incidents that session, such as the spinning of boiled and unboiled eggs, and of all sorts of gyrostats, the bursting of a big india-rubber bag containing many gallons of water, designed to illustrate the formation of a dew drop, the turning of the big wheel in the window to find the horse-power of two students. But the last day of my course is the most vivid of all. We had had no lectures on sound during the previous part of the session. But this day, strange to behold, the lecture table was crowded with all sorts of apparatus on the subject—monochord, siren, sand plates, tuning forks, organ pipes, French horns, &c. The lecture began at 9 a.m., at 10 o'clock he announced that any one who specially wanted to leave for another class could do so, but that he wished to show one or two other experiments in sound. A similar announcement was made at 11, and again at 12. The last experiment was shown at 12.30 and the dozen of us who were left vigorously sang 'Auld Lang Syne' at the close."

In 1901 I read a Paper on "Kelvin's Electric Measuring Instruments." It is noteworthy that a considerable number of the instruments described and illustrated in the 1901 Paper are not now being manufactured. Those which are still manufactured have been subject to continual improvement of detail and arrangement to meet the varying conditions of practical use and manufacture, but the basic principles as laid down by Lord Kelvin are maintained in their design.

The author describes some of the modifications that have been introduced.

I have always thought of Kelvin as one of the most gifted and successful of mankind alike in his early distinction, the length and brilliance of his career, his wonderful genius, and the uniform physical health, which enabled him to carry on his work, so that almost to the end it might be said that his eye was not dimmed nor his natural strength abated.

In an appendix are given some 60 letters from Kelvin, some of them facsimile, received by the author from 1886 onwards. They refer largely to experiments which were being carried out in the laboratory.

The Fourth Colourless Sensation.—A contribution by Sir William Abney to the Proceedings of the Royal Society, [illegible] certainly helps to explain many phenomena otherwise in- [illegible]

The Electrician.

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Power in Electrochemical Industries.

That cheap power is of the greatest importance in electrochemical industries is recognised by every engineer. In some cases, indeed, the cost of power may be said to be the governing factor, and, as a case in point, it is for this reason that nitrogen fixation processes have flourished to such a large extent in Norway where water-power can be developed more cheaply than in most other countries.

On the other hand, the cost of power is by no means the only question to be considered. There are, for example, many cheap water powers to be found in the United States, and there are also electrochemical industries which are crying out for cheap power in the self-same country. Nevertheless these water powers are not being developed, and the fact remains that these industries chiefly remain in the neighbourhood of Niagara where the cost of electric power is not abnormally low, as water powers go. That this apparent contradiction exists is due to the fact that cheap water power in itself is not necessarily an attraction, and just as it does not pay to transmit electrical energy beyond a certain distance, similarly it does not pay to transport manufactured articles beyond a certain distance or to transport materials for manufacture. In fact, the one cost may be expressed quite easily in terms of the other.

This question was discussed very clearly last year by Mr. F. A. Lidbury in a Paper read before the Western Society of Engineers in the United States. As an example, Mr. Lidbury took the case of aluminium, which is extremely light for the amount of power it represents, and which, therefore, takes a fairly low freight rate in comparison to power consumption per pound. In that case it appears that a 3,000-mile haul would be equivalent to something like £2. 10s. per horse-power year in power; therefore, disregarding the cost of raw materials as affected by locality, it would be necessary to obtain power at a lower rate to the extent of £2. 10s. per horse power year to place manufacturing on the west coast of America on an equality with that on the east coast. It appears that the price commonly obtained in the United States is about £4 per horse power year, so that equivalent power would have to come down to £1. 10s. per horse power year. Aluminium, however, is a very favourable example. In the case of electrolytic alkali industries it appears that not only would it be necessary to obtain the power for nothing, but also to receive a bonus of from $5 to $10 for every horse power year consumed. In the case of caustic soda, bleaching powder and electrolytic alkali the difference appears to be still greater, amounting to something like £70 per horse power year. It is only owing to the much cheaper freight by sea than by land that the industries of Norway are able to compete and are not at a disadvantage, not merely owing to the cheap cost of their water power. Having regard to these facts it is easy to see why electrolytic industries remain mostly in the neighbourhood of Niagara. It is simply due to the fact that by so doing they are practically within 500 miles of all the manufacturing districts.

It follows then that certain industries tend to move about from one district to another if there is an opportunity of getting well into the centre of a district where the product is to be used, even if the cost of power in that district is somewhat higher. On the other hand, certain other industries may move away (such, for instance, as synthetic nitrates) to some locality where the power is very much cheaper even if the freight is considerable.

Mr. Lidbury also makes reference to the question of off-peak power. The conditions obtaining from this point of view in the electrochemical industry are not always properly appreciated by electricity supply engineers. The station engineer desires to distribute his capital charges to greater advantage by selling power of this kind, and, therefore, he is willing to make a considerable reduction. On the other hand, he is apt to forget that electrochemical processes are frequently carried on night and day, thus approaching a 100 per cent. load-factor. If power is to be supplied intermittently on the off peak principle this means that the station engineer improves the load-factor of his station, but diminishes the load-factor on the chemical plant. Consequently, in order to maintain equivalent output the manufacturer must install more plant, and unless the terms on which power can be supplied are very advantageous the bargain is not a good one for the manufacturer. In fact, Mr. Lidbury goes so far as to say that, in his experience, it is always better to pay the higher price for power which can be used the whole of the 24 hours, thus maintaining 100 per cent. load-factor on the chemical plant. In this connection it must be remembered that not only is it a question of increasing the amount of plant, but also of interrupting continuous processes if off-peak power is taken, and this may lead to much more loss of time than is suggested by the mere interruption of the power supply.

From the point of view of this country, although we lack water power, we have at least the satisfaction of having all our activities compressed within a comparatively small area, and consequently some of the economic problems which arise in the United States do not trouble us to the same extent in Great Britain.

Reviews.

A Laboratory Course of Practical Electricity for Vocational Schools and Shop Classes. By M. J. Archbold. (London: Macmillan & Co., Ltd.) Pp. ix. + 211. 5s. net.

This manual contains 98 experiments of an elementary nature, divided into groups for four semesters. Each test occupies a page and the order of the experiments may be changed at will as a loose-leaf arrangement has been adopted. The book is intended to be used as a laboratory note-book, and to this end each page contains blank tables and curve sheets where necessary, and the text is printed with blanks for the student to fill up as he performs experiments. In many cases questions arising from the results obtained are set with spaces for the student's reply. This mode of treating experimental work has advantages, especially where large classes have to be supervised by a small staff of teachers, but it may be contended that it robs the work of the initiative that should be cultivated in the learner. The first semester's work covers simple magnetic experiments, use of voltmeters and ammeters, cells and measurement of resistance; the second semester, the resistance of various wires, heating of conductors, energy loss, testing of supply meters, photometry, electromagnetism and induced currents; the third semester, the testing of direct-current motors and dynamos; the fourth semester, simple alternating current tests including measurement of resistance, reactance, impedance, power-factor, tests on transformers, auto-transformers and alternating-current watt-hour meters.

The filling in of the blanks left in the text is an occupation strongly reminiscent of "missing word competitions," and

sometimes presenting difficulties not purely electrical. As an example, in the experiment designed to show the use of the voltmeter the student is told to connect this instrument in series with a bell and battery and to fill up the blanks in "the bell ...... ring. The voltmeter ...... back the current. A voltmeter should always be connected in ...... to get the drop in volts."

The clearness of the text suffers in a number of places from rather loose expression. It would be difficult for a student to carry out literally the operation described in the sentence: "The copper plate was removed and all the bubbles wiped off and replaced." The following sample sentences also require attention:—"Salammoniac was put in a battery jar and water poured in until the jar was one-third full and stirred thoroughly"; "How will an increase of resistance having the same voltage affect the flow of current?"; "The mil-foot is a standard measure...... Its value is one foot long and one circular mil in cross-sectional area"; "the core or iron loss is due to induced currents in the iron of the transformer called eddy currents and the loss caused by the iron resisting the continual change in the magnetism (this is sometimes called molecular friction) and called hysterisis (sic)." In experiment No. 21, the words "short-circuited" and "out of circuit" are used with the same meaning. In No. 26 the letters A and B denote two binding posts and are subsequently used in an equation to denote two resistances.

Among the technical inaccuracies we find the weight of a pint of water given as 1 lb.; in an experiment, the object of which is to verify the connection between watt-seconds and Thermal units. In No. 26 the word "force" is used in place of "torque." In No. 80 instructions are given to draw a line representing the effective value of a sine function so as to lie above the zero line for half a period and below it for the next half-period, and the statement is made "the line drawn represents the effective E.M.F. . . : . . . . and would be equal to a direct *current* of this value."

In No. 92 the input to a transformer on non-inductive load is wrongly given as the product of the primary voltage and current. In No. 93 it is rather misleading to say that "when using alternating current the auto-transformer is used much in the same way as a variable resistance is used with direct current." At the end of the book a series of diagrams of connections are given corresponding to the various experiments. It appears that Figs. 32 and 33 should be interchanged.

Supplemented by text-books and efficient teachers the course will give a good grounding for the elementary students for which it is designed. A. J. M.

Calcul des Lignes Aériennes au Point de vue Mécanique par des Abaques. By ANDRE BLONDEL. (Paris: La Lumiere Electrique.) Pp. 63. 5 fr.

As we should expect from an engineer of the author's reputation, the present short work is a notable contribution to the literature of overhead transmission lines, and it is strictly limited to mechanical design problems. Mr. Blondel relies on charts for determining quickly the tension to be allowed for the erection of hard-drawn copper and aluminium conductors as well as the height of the supports and the stresses for which these must be designed under all conditions of length of span, windage, frozen snow and temperature. He gives a lengthy account of the charts which he published in 1902, 1910, 1912 and 1913, and describes the mathematical bases of each and their limitations. It is particularly pleasing to see that allowances are made for the expansion of the conductors and for their elastic properties. This is as it should be but it demands a very careful investigation of the wind, snow and other conditions for which allowance must be made. This is followed by an equally full statement of the applications of the charts to various conditions. The practical nature of the work is shown by the attention which is paid to lines on which either rigid or flexible insulators are used.

The third chapter shows how the charts may be used for calculations in designing poles or towers. In an Annexe the author develops a further 1914 chart which can be read with great accuracy, and the one for aluminium is given as an illustration. All the four charts and two diagrams of coefficients can be bought separately to a large scale for 5 francs extra from the offices of "La Lumiere Electrique." It should be mentioned that metric weights and measures are used throughout, so that the immediate usefulness of the work to British engineers is limited. There is, however, no apparent reason why the author's method should not be used for the construction of charts with British units, and it is to be hoped that the author may arrange for them to be prepared. It would then be possible to compare them with those of Pender, Still and other workers, a bibliography of whom is very fairly given by Mr. Blondel. B. W.

Electrical Cooking as Applied to Large Kitchens.

The following is an account of a discussion which took place before the Manchester Local Section of the Institution of Electrical Engineers on Mr. W. A. Gillott's Paper on the above subject. An abstract of the Paper appeared in our issue of December 7, 1917:—

[illegible]

[illegible] water, where there was a big supply of steam available it ought to be employed, but if it was necessary to develop steam specially for the purpose the question to be considered was the supply of washing water, cooking water and water for baths and wash-bowls.

Mr. H. A. Ratcliff said that he could not help wondering where the work of the electrical engineer finished and that of the chef commenced. Personally he had always considered that under present circumstances electrical water boiling was not a commercial proposition, at any rate, with current over ½d. per unit. Until current could be obtained at that figure the supply of hot water in bulk was better left alone for the time being. Some of the heating apparatus one came across gave the impression that the manufacturers were suffering from the want of full information on design. In the list of advantages he was surprised to see there was no reference to hygienic considerations. The speaker thought that was almost the chief advantage of electrical cooking apparatus. The theory of the decreased loss of weight in meat had been thoroughly exploded a long while ago, and where it existed was probably due to excess of moisture. The real cause of it was probably in the ventilators, and that was a condemnation of the type of apparatus employed. With regard to the load curves, in most manufacturing districts the works shut down at about the same time. The British workman usually wanted his dinner as soon as he had stopped work, and therefore the cooking load would clash with the works load. In the case of domestic cooking it would depend upon the neighbourhood whether this was the case. In winter time there would surely be a considerable clash with the suburban cooking load. The remedy for that was copper all the time.

Mr. Allcock said it was quite wrong, as far as could be seen to-day, to expect to boil water in any quantity electrically. It was essential in fish frying to bring the fat to a very high temperature before the fish was plunged into it, and with electrical heating it took a long time to bring the fat to the required temperature. That difficulty did not appear to have been satisfactorily overcome. Water boiling and fish frying were outside the range of practical politics with the electrical kitchen to-day. In boiling plate design the trouble had been the distribution of the heat. [illegible] down frequently appeared to develop hot spots, which ultimately gave way. That might be due to slackened terminals, disintegration of mica or other causes. The boiling plate to-day was the least efficient part of the kitchen apparatus. Other speakers had dealt with wiring faults and maintenance. If we could not have reliability we could not have electrical cooking. The lack of reliability was probably due to the fact that there had been relatively very little experience of the design of that class of apparatus. He was grateful to one of the speakers for the suggestion that cast-iron clamps should be used and also for the very valuable hint in regard to the possibility of loading a boiling plate if [illegible]

Mr. H. R. Burnett said he wished that Mr. Gillott had been able to give a few figures with regard to the comparative cost of gas and electricity. Had the author dealt entirely with the black type of hot plates? They might be all very well for canteen work, where special utensils were provided, but his experience was that the ordinary domestic consumers would not have black hot plates; in cases where they had tried them the invariable complaint was that they were too slow, whereas the radiant type gave great satisfaction. He introduced that type five or six months ago, and had put in about 100 with hardly any complaint.

Mr. H. D. Symons said the question of first cost and running cost was [illegible] the apparatus cheap, and [illegible] electricity than by gas. His [illegible] In every mode of life [illegible] comparison with the question of convenience. It was reliability first and convenience next, but people [illegible] the raw materials that were [illegible] whereas [illegible] the author gave some information [illegible] Presumably they were [illegible] so popular. His experience was that after a few months' service, even though it might still be in [illegible]

speakers had raised the question of pre-heating. To go into that subject would require another Paper. The pre-heating of water by coke or steam was, of course, necessary where electricity was not so cheap as some would like. In installation B it would be noticed that all the water boiling was carried out by electricity in that particular case. The washing-up arrangement in that case had been carried out by the water obtained from the domestic supply. In installation A the pre-heating was done in a unique manner. The water for the domestic supply was carried in a pipe through the calorifier. There was a coil put inside a tank. The water ran through this coil. In the coil there was a tin full of water, and the heat given off the coil heated the water to the desired temperature. Some of the speakers mentioned the fact that there was mica and mica. He did not wish to support mica to the last degree, but it was only where mica was used in open work such as oven work or radiator work that trouble was experienced. In the maintenance analysis, installations A, C and D were not mica elements; installation B were mica elements. In A and C the grills were not mica, in B and D they were. There again a difference was seen; where the mica was in open work the costs were higher. On installation A those records were obtained in the first year's work, B in the second year, C in the third year and D in the second year. Of course, D could not be compared favourably, because, as pointed out, it had an exceedingly high cost of maintenance. The question of the reduced loss in weight has been mentioned. A lot of people said it was water, but he had found that the saving of the shrinkage of meat alone had paid for the electricity. In another test he procured two joints taken off the same beast, one weighing 23½ lb. the other 23 lb. The former was put into the gas oven, and when it was turned out it weighed 18 lb., a reduction of 5½ lb. The 23 lb. joint was put in the electrical oven, and it weighed 21 lb. when it was turned out. At the very least there was a saving of 10 per cent. As the concern paid £120 per month in butchers' bills a saving of 10 per cent. represented £12 a month, and that would pay for the whole of the electricity. He was pleased to note that Mr. Weaving supported the solid type connection. A majority of the wiring faults had not been in the ovens, but merely in the metallic tubes from the hot-plates to the terminal chambers, and in many cases in the terminal box itself behind the cooker. A solid type of boiling table, which overcame the difficulty of this wiring trouble, had been shown. Firstly, the solid type prevented any electricity going through; secondly, there was no insulation other than air insulation. A point had been raised about the relative cost of gas and electricity. Take installation A. When first approached those people were paying £290 per year for gas cooking. Electric methods gave them 160,000 meals per annum, feeding 1,500 persons daily six days a week. After the year's work they had not only increased the number of persons catered for, but also the cost to them had been much less proportionately than when they used gas. Safety had been a great point with them. Mr. Allcock raised the question of fish frying. In installation A there were 850 portions of fish and 15 cwt. of potatoes cooked one Saturday, which disposed of any idea of fish fryers not being a success. Of course, it depended entirely on what was put into the apparatus. Using an ordinary pan or a shallow pan you were not going to get the right result, because you could not get the required amount of heat on the hot plate. To obtain satisfactory results you must have a self-contained utensil. If you left them a little too long it spoilt the food. The difficulty lay in the regulation of heat. As regards the thermostatic control, this was not advocated. No one cooked only one class of food. For example, different temperatures were needed for beef and steak and kidney pie. That would mean two different ovens. Thermometers were unreliable. They might be right for the first few times of using, but if the oven was overheated the bulb very often burst. The fat in the cooking splashed them, the fumes got about, and the thermometer could not be read. It was far better to use your touch. It was more convenient to judge from the size of the oven and by experience, of the time required at full heat. At installation A they cooked something like 400 small beef pies per week. They knew how long it would take, so they filled the oven, left them for a time, and then came back when the pies were ready.

The Present and Future Electric Street Lighting in Islington.*

By HAYDN T. HARRISON.

In accordance with the requirements of the authority appointed under the Defence of the Realm Act, instructions were issued, based on observation from the air, that no unscreened lights should be visible from above, and that the illumination on the road or pavement should be reduced in value. Complaints have arisen that the [illegible] illumination in Islington was lower than in other districts. This impression, however, is not correct.

It has been suggested that the diminution in lighting could be more economically carried out by substituting half watt incandescent lamps for the existing arc lamps now in use. Where possible this has been done. In April, 1917, 120 out of 284 open type [illegible] and 92 out of 240 flame arcs were so converted. But the [illegible] alternating current adopted nearly 25 years ago [illegible] alteration being carried out in entirety. This [illegible] beneficial in the future, as the possi[illegible]

[illegible] Metropolitan Borough of [illegible] 1917.

About 1912-1914 considerable advances in the lighting of certain districts, notably the City of London and Holborn, were carried out. Information thereon was placed before the Islington Lighting Committee; but the illumination was not increased to the standards demanded by modern requirements, chiefly because of the wide separation between the positions of the light sources in the streets.

As regards the substitution of half-watt lamps, according to a method involving an alteration of the system of distribution, it appears that this would not be advantageous so far as after-war conditions are concerned.

The approximate candle-power of the electric street lamps in use before the war were 500, 700 and 2,500 respectively. The former were spaced 180 ft. apart, the latter, on the average, 260 ft.

The minimum illumination based on the standard specification (drafted by the Joint Committee of the Institutions of Gas and Electrical Engineers, the Institution of County and Municipal Engineers, and the Illuminating Engineering Society) would have been approximately 0·022, 0·03 and 0·044 ft.-candles respectively; the two former thus coming under Class B (0·025 ft.-candles), the latter under Class C (0·04 ft.-candles). It can be shown, however, that, spaced as the lamps are at present, after the war demands would not be satisfied by altering the present flame arc lamps, and no gain would result from changing the 500 c.p. and 700 c.p. lamps to any type of lamp other than flame arc lamps. It is necessary to bear in mind both immediate economies and conditions after the war.

So far as immediate economies are concerned the estimates provided by the engineer for operating half-watt and arc lamps are as shown in the table:—

TABLE.—*Annual Cost of Operation.*

Half-watt lamps.	£	s.	d.	Arc Lamps.	£	s.	d.
250 c.p. (150 watts) ...	8	15	10				
500 c.p. (300 watts) ...	13	17	6	500 c.p. rectified ...	17	14	6
800 c.p. (500 watts) ...	19	10	10	700 c.p. alternating	22	18	5
1,600 c.p. (1,000 watts).	33	4	2	800 c.p. alternating	25	5	11
2,500 c.p. (1,500 watts).	46	17	6	2,500 c.p. flame arc	25	11	5

From these data it appears that a material saving could be made by installing lamps of lower candle-power during the war; for example, £17 per lamp per annum could be saved by replacing the 2,500 c.p. lamps by 250 c.p. lamps. On the other hand, if it were necessary to revert to 2,500 c.p. lamps after the war, using half-watt lamps, a loss of £21 per lamp would result, plus the capital cost of changing over. Moreover, such a scheme would make it difficult to improve the illumination after the war, owing to the high annual cost of more powerful lamps. Preferably, any scheme adopted for present economies in annual expenditure should form part of a scheme for improving conditions after the war.

This is complied with by the following scheme: If lamps are placed at 130 ft. and 90 ft. apart a minimum illumination of 0·1 ft.-candle is obtained when lamps of 800 c.p. and 300 c.p. are used. The use of 250 c.p. and 500 c.p. lamps would enable the illumination to be increased three times. These positions are equivalent to the addition of lamps midway between existing lamps, and would involve alteration of connections to existing mains, but not new mains, the new posts and fittings being erected on the present lines of mains, and connected to the same when they have been changed to the short parallel system. The annual cost of all these lamps would be less than that estimated for after war prices of arc lamps:

Arc Lamps.				Half-watt Lamps.			
No.	Watts.	Illum. (ft.-c.)	Cost.	No.	Watts.	Illum. (ft.-c.)	Cost.
90	500	0·02	[illegible]				
137	700	0·03	[illegible]	730	150	0·08	[illegible]
123	800	0·03	[illegible]				
200	700	0·044	[illegible]	280	300	[illegible]	[illegible]

[illegible]

[illegible]

[illegible]

The total cost of the scheme would thus be about £12,000. The additional posts and lanterns could be erected as required, the illumination would be brought up to that in the most modern installations, and the annual cost of operating would be less than before. The scheme would also permit of considerable present saving as each circuit, when converted, could be fitted with low candle-power lamps to fulfil the requirements of the Defence of the Realm Authority.

Correspondence.

NATIONAL UNION OF SCIENTIFIC WORKERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Will you allow me to explain further the nature and objects of this Union, of which an advertisement is appearing in your columns?

It is generally recognised that there is a great and increasing danger that, in the work of "reconstruction," claims of science to its rightful place in the national life, as well as the interests of its workers, will be overlooked. The founders of the Union believe that the danger will be averted if scientific workers adopt that form of organisation which has proved in the past, and is likely to prove in the future, the most effective method of exercising political and industrial influence. The essential characteristic of this form is that the Union shall be completely representative or, if possible, completely inclusive of all members of the profession on an equal footing.

It is such a Union that we are trying to form. The qualifications for membership are "adequate scientific training," and the "everyday practice of science," qualifications possessed, of course, by a great number of electrical engineers.

Feeling that it would be absurd for any self-appointed body to lay down rules permanently binding such a Union, the originators are confining their efforts for the present to setting up a preliminary organisation, which will result in the summoning of a general meeting having the authority necessary to place the Union on a permanent basis. In the pamphlet which they have issued (for which all who are interested are urged to write) some suggestions for aims and methods of action are given, but the main part is devoted to a description of the preliminary organisation. They would urge that, while the details of the constitution of the Union are still unsettled, a disagreement with those suggestions is no reason for refraining from taking part in the organisation.

We are often asked what is our attitude to existing professional bodies. Of course we recognise to the full the necessity of the work that they are doing, chiefly in regulating the internal affairs of the profession. But most of them do not attempt to exert external influence, and least of all political influence, for which their origin and constitution renders them entirely unfit, just as the constitution of our Union would make us entirely unfit to meddle in the matters which are now in their charge.—I am, &c.,

NORMAN [illegible] CAMPBELL,
General Secretary, N.U.S.W.

North Lodge, Queen's Road, [illegible]

12½ PER CENT. AWARD.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: May I, through your columns, [illegible]

[illegible]

obscurity enveloping the words "technical staff" given in Sir George Askwith's award, and consequently injustice is likely to be inflicted upon a large number of clerical staffs through possible misunderstanding of its broad application (in many cases, it may be, through no lack of appreciation of the staffs by the engineer and manager, but through an unintentionally mistaken distinction between the functions and relative importance to the undertakings of the engineering and the clerical sides, to the prejudice of the latter), the essential fact being overlooked that an electricity works technical staff must comprise not only the engineering but the concomitant clerical section of the complete works organisation.

It need scarcely be mentioned that the clerical staffs as a whole (amongst whom are many highly competent men belonging by virtue of examination to professional organisations relating to their craft, just as do the engineers) are amongst the most whole-heartedly and consistently loyal and capable assistants of the engineer and manager, and of his subordinate engineers; but though he is the first to acknowledge this fact, his desire for their due recognition by others is occasionally liable to be over-ruled.

In the name, therefore, of the large and essential body of your readers constituting the staffs in question, I venture to appeal to you to exert your valuable influence on their behalf to obtain from Sir George Askwith himself his definite ruling that the clerical sections of the technical management of electricity generating works are within the scope of the word "technical" as employed by him in his Award.

This ruling would settle the question finally and would appear to be necessary, as it is neither just nor desirable that each undertaking should be left with the option of placing its own construction upon a Minister's award, the purpose of which is strict *uniformity* of application.

You will, of course, be aware that the Bristol Electricity Committee, and H. F. Proctor, Esq., their engineer, have given the word "technical" its broad interpretation by applying the award to "all employees of the department (both sexes) whether engaged on generation, distribution, office work or management, or otherwise, who are in receipt of a net wage or salary not exceeding £250 per annum.

If you could, therefore, obtain Sir George Askwith's pronouncement to the effect that the interpretation of the Bristol department is correct, and that all undertakings must act in accordance therewith, you would not only remove the existing anomaly but render a lasting service to the whole of the clerical members of the works organisations.

Apologising for the length of this letter, and assuring you of our keen appreciation of any steps you may be good enough to take in the matter on our behalf.—I am, &c.,

Feb. 7. CHIEF CLERK.

Legal Intelligence.

Aldworth v. Smith.

At the Nottingham Assizes on Saturday, Mr. John Aldworth, general manager of the Corporation Tramways, sued Mr. O. E. Smith for damages for libel. The libel consisted in an accusation against plaintiff that he [illegible] to the danger of the public, and there also [illegible]

[illegible] appeared for the plaintiff, and defendant appeared in person.

[illegible] that Mr. Aldworth had been 19 years manager [illegible] and defendant, who was living at Bulwell [illegible] a transfer ticket from Hucknall-avenue [illegible] that he was [illegible] a series of letters to Mr. Aldworth [illegible] the subject. He also [illegible] against plaintiff and [illegible]

[illegible] defendant's allegations [illegible]

[illegible] the jury [illegible] the Lord [illegible]

Patent Record.

SPECIFICATIONS PUBLISHED.

[illegible]

18,552 SOC. ANON. POUR L'ECLAIRAGE ELECTRIQUE DES VEHICULES. Apparatus for advancing the spark in internal combustion motors. (9/9/16.) (Addition to 17,934/16.) 109,781.

18,611 CAKLIAR, I. Electric accumulators. (29/12/15.) 102,976.

1917 SPECIFICATIONS.

38 SMITH, P. F. & ROBINSON, V. S. Method of and means for automatic electric control of petrol-electric and other electric transmission vehicles. (2/1/17.) (Cognate application 1,095/17.)

90 YANAI, T., OHTANI, G. & YAGO, S. Electric lamp or other vacuum tube having a copper leading wire. (26/1/16.) 103,648.

368 ARMSTRONG, WHITWORTH & CO., SIR W. G. & CHEETHAM, A. S. Apparatus applicable for electric lighting. (8/1/17.) 112,320.

2,475 MCLEAD, T. Electric switches. (20/2/17.) 112,344.

5,528 YUYAMA, S. Electric incandescent lamps. (19/4/16.) 105,764.

6,023 HYMAN, S. M. & STOLS ELECTROPHONE CO. Electrophones. (28/4/17.) 112,366

7,557 JOHNSON, F. I. Terminal for electric conduit. (14/2/16.) 111,834.

10,072 ELECTROLYTIC ZINC CO. Electrolytic anodes. (26/7/16.) 108,311.

10,588 JACKSON, W. J. MELLERSH. (Phillips-Brinton Co.) Contact makers and interrupters for ignition systems. (4/1/17.) (Divided application on 177/17.) 112,391.

11,035 IGRANIC ELECTRIC CO. (Cutler-Hammer Manufacturing Co.) Electric circuit controllers. (31/7/17.) 112,393.

14,430 AKT GES. BROWN, BOVERI ET CIE. Magneto-electric ignition apparatus. (31/10/16.) 111,100.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

January 23, 1918.

1,301 MACCALLUM. Incandescent lamps.
1,313 HORNBY. Storage batteries.
1,315 PLATT, BROS. & CO. & COLIN. Apparatus for electro-plating articles having holes.
1,318 WILSON. Telephone apparatus.
1,321 FULLER ACCUMULATOR CO. & BROWN. Lamps for aircraft.
1,333 REVELL. Swing bracket for electric lighting.

January 24, 1918.

1,359 DITCHFIELD. Self-generating electric power plant.
1,361 WHIPP. Incandescent lamps.
1,376 JACOBY & MOSSAY. Cooling dynamo-electric machines.
1,377 BARR & STROUD & MACGILL. Step by step receivers working on magnetic gearing principle.
1,387 SPLITDORF ELECTRICAL CO. Ignition system. (18/5/17, U.S.)
1,399 LAYTON. Incandescent lamps.
1,402 FERRIER. Telephone receivers and transmitters.
1,407 JAGGI. Electric igniter for combustion motors. (24/1/17, Switzerland.)

January 25, 1918.

1,430 THOMAS. Electric fuses.
1,440 DAY. Brush connections for electric motors and dynamos.
1,463 B.T.-H. CO. (G.E. Co.) Safety lamps.
1,468 ELLISON. Electric resistances.
1,483 SUCHOSTAWER. Magneto motor.
1,493 POLINKOWSKY (Western Electric Co., partly.) Machine switching telephone systems.

January 26, 1918.

1,531 HOYT. Transmitter diaphragms.
1,539 HUNT. (Bryant Electric Co.) Electric attachment plugs.
1,540 RUTHERFORD. Electric lamp holders.
1,567 PHŒNIX DYNAMO MFG. CO. Plunger type brush holder with pivoted head.

January 28, 1918.

1,577 ARCHER & BEIN. Locking device for electric lamp holders.
1,610 NEVILLE. Instrument for teaching Morse code.
1,620 PIEPER. Electric machines.
1,626 PURDAY. Glands and stuffing boxes for electric cables.
1,627 & 1,632 SUBMERSIBLE & J. L. MOTORS (LTD.) & WHITEHORN. Dynamo-electric machines.
1,634 R. BOSCH AKT. GES. Devices for regulating voltage. (26/1/17, Germany.)

January 29, 1918.

1,686 B.T.-H. CO. (G.E. Co.) Storage battery charging systems.
1,687 SUCHOCTAWER. Dynamo-electric machines.
1,690 JUHLIN & PECK. Dynamo-electric machines.
1,697 A. G. BROWN, BOVERI ET CIE. Electric ignition apparatus for internal combustion engines. (13/2/17, Germany.)

Volunteer Notices.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Oxford-street, W. 1.

Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.

Orders for the Week.

Officer of the Week.—Sec. Lieut. H. J. Golding.

Next for Duty.—Lieut. P. Bowden.

Monday, Feb. 18.—No. 3 Company, 6.30-8.30. Recruits' Drill, 6.30-8.30. Signalling Section, 6.30-8.30.

Tuesday, Feb. 19.—Lecture on Demolitions at 6.30. Physical Drill and Bayonet Fighting, 7.30.

Wednesday, Feb. 20.—No. 1 Company Entrenchments, &c., 6.30-8.30. Recruits' Drill, 6.30.

Thursday, Feb. 21.—No. 2 Company Entrenchments, &c., 6.0-8.0. Recruits' Drill, 6.30-8.30. Signalling Section, 6.30-8.30. Ambulance Section, 6.30-8.30.

Friday, Feb. 22.—Musketry, 5.30-8.0.

Saturday, Feb. 23.—Knotting, &c., for the whole Corps, 2.45-4.45. Musketry, 2.45-4.45.

GENERAL NOTICES.—All Drills will take place at headquarters unless otherwise stated.

Recruits will attend for engineering instruction with the Companies.

The Medical Officer will attend on Thursday evening for the examination of recruits.

N.C.O.s and men may attend parades with companies other than the one to which they are attached.

Commercial Topics.

Excess Profits Duty.

On the application of the British Ignition Apparatus Association (Ltd.) the Board of Referees has fixed the statutory percentage at 11 per cent. for companies engaged in the manufacture of magnetos for ignition purposes, and 11 per cent. plus 2 per cent. in the case of other businesses.

* * * *

Electricity Supply as a Key Industry.

The Council of the Newcastle-on-Tyne Chamber of Commerce has decided to put on the agenda at the next meeting of the Associated Chambers of Commerce Conference a resolution urging upon the Government to recognise the public supply of electrical energy as a key industry, to amend the defective legislation governing electric power, to encourage the establishment by private enterprise of an adequate electrical supply, and to conserve our coal resources.

* * * *

Co-operation of Tramway Undertakings.

The recently constituted Board of Trade Tramway Committee has issued a circular letter to tramway undertakings, asking for co-operation in forming Area Sub-committees. The circular states:—

It will be apparent that the work involved is of great magnitude and of national importance, and the committee have been giving very serious consideration to the machinery which they will set up for the purpose of carrying out the duties imposed upon them by the terms of their reference. For this purpose it has resolved to divide the country into nine areas, which will be placed in four groups under sub-committees of the committee to be termed "Area Sub-Committees." The nine areas will be as follows: (1) Metropolitan and East Coast, (2) South East and South to Bournemouth, (3) South West and South excluding Bournemouth, (4) Midlands, (5) Lancashire, Cheshire and Wales (North), (6) Yorkshire and Lincolnshire, (7) Northern, (8) Scotland and (9) Wales (South).

To assist the Area Sub-Committees in carrying out their investigations, it has been decided to invite representatives of the tramway undertakings in each area to act in a consultative capacity as local advisory committees. I am, therefore, to inquire whether my committee may rely on the co-operation of your Tramways Committee in giving effect to these proposals.

It is stated that there has been an immediate and favourable response, and already a large number of undertakings in important centres have signified their willingness to co-operate in forming the Area Sub-Committees, and in many other cases the chief executive officers have promised their active assistance.

* * * *

Proposed British Manufacturers' Corporation.

Sir Charles Mandleberg, chairman and managing director of Messrs. J. Mandleberg & Co., of Pendleton, is placing before British manufacturers and producers an interesting scheme on national lines for the extension of the British export trade after the war.

That a large extension of our export trade is vitally necessary if we are to provide continuous employment and successfully carry the large burden of taxation that will be our permanent portion is not to be denied, and it is equally undeniable that preparatory action is urgently necessary in order to be ready when peace is restored. Sir Charles Mandleberg proposes the formation of a British Manufacturers' Corporation for the [illegible] purpose of [illegible] and obtaining, by means of direct effort on the spot, increased trade in foreign markets. No existing association has the [illegible] object [illegible] the new scheme would take [illegible] of manufacturers and the proposed Corporation would not overlap or compete with other bodies of manufacturers. The proposals are not antagonistic but complementary to the Government's plans for extending the export trade. The British Manufacturers' Corporation would not be a trading company for the earning of dividends [illegible] the [illegible] which would [illegible] for [illegible] the export trade [illegible].

[illegible]

selected for their knowledge of export trade routine. Sir Charles Mandleberg contemplates a membership of a thousand as a beginning, with a subscription of £100 or £200. With an annual fund of £100,000 or £200,000, very strong inducements could be offered to the right men to become "agents-in-charge." The proposals are, we are informed, being very well taken up by manufacturers in all parts of the kingdom, and as soon as a sufficient number have intimated their approval a Provisional Committee will be formed to establish the British Manufacturers' Corporation.

* * * *

Manufacture of Goods in Australia.

The draft of the Public Contracts Bill, which was recently passed by the Victorian Legislative Assembly provided that all goods of the value of £100 purchased by local authorities must be of Australian manufacture, unless the Minister certified that the goods could not be obtained in Australia except at an unreasonable price or after undue delay. The Legislative Council raised the maximum allowance of imported goods from £100 to £500. On the Bill going back to the Assembly there was opposition to the amendment, but eventually the House agreed to compromise by raising the amount to £250.

Electricity Supply.

Extensions.

Barrow-in-Furness. At the last meeting of the Council it was decided on the recommendation of the Committee, to apply for sanction to borrow £15,387 for a new generating set.

Bedford.—The Council has decided to put down an additional generating set of 1,500 kw. at the electricity works.

The chairman of the Electric Lighting Committee (Mr. Sowter) stated at the last meeting that the output for some time varied from 2,530 kw. to 2,590 kw. Their generating plant was capable of 2,750 kw., but the capacity of the boilers was only 2,600 kw. They hoped to get the new plant working by March or April, and that would give them an additional 1,500 kw. Their obligations would then be increased to 3,975 kw., as against a capacity of 4,100 kw., leaving a margin of only 125 kw. As against that, the Council had already received applications for energy from certain firms for 760 kw. The financial aspect was set out fully in the engineer's report of Jan. 11. The additional turbine would save at least 10 per cent. on coal, or £1,400 per annum, and that part of their plant which it was uneconomical to run at the present price of coal would be brought down from 38 per cent. to 18 per cent. They were told that factories were coming to Bedford, and the town must keep abreast of the times.

Blackburn. The Council has decided to apply to the L.G. Board for sanction to borrow £115,000 for a new electrical generating station at Whitebirk.

The Electricity Committee had previously considered, and adopted, a report by borough electrical engineer (Mr. P. P. Wheelwright) on the urgent necessity of providing a proper supply of electricity for the town, and to economise in coal consumption. They had recommended that steps be taken at once to erect on the site at Whitebirk the first instalment of the plant at the proposed new works, to consist of a 5,000 kw. generating set, and that arrangements be made, if possible, with the Gas Committee for the boilers to be provided.

Elland. Application has been made to the L.G. Board for sanction to a loan of £2,000 for electricity supply extensions.

Newcastle (Staffs.). On the recommendation of the Electricity Committee, it has been decided to apply to the L.G. Board for sanction to borrow £3,000 for linking up the electricity undertakings of Newcastle and Stoke-on-Trent.

Stepney (London). Acting on the advice of the engineer and manager of the electricity works, Mr. W. C. P. Tapper, the Electricity Supply Committee recommend the erection of an additional sub-station in the [illegible] part of the borough at an estimated cost of £12,000.

Wolverhampton. Application is to be made to the L.G. Board for sanction to borrow [illegible] £1,[illegible] for [illegible], and [illegible] for a 300 k.v.a. transformer. [illegible] the Lighting Committee [illegible] that the [illegible] and that [illegible] between the [illegible] at a cost of £1,[illegible] have been approved and tenders are to be obtained.

General.

A.E.S.E. Progress. The annual meeting of the Association of Electrical Station Engineers [illegible].

[illegible]

[illegible] and, in consequence, many applications were refused. He hoped that in the near future the Association would cater for a junior section. The Committee had kept in touch with the kindred Associations in Scotland and the Provinces, and at the National Conference to be held on the 11th inst. representatives from these would be present.

The secretary (Mr. W. A. Jones, Leyton), read the annual report, in which he mentioned those cases of members' disputes with employers which the Association had been compelled to take to arbitration, and in all of which they had been successful in their claims. The membership now comprised all grades of technical staffs, from chief assistant to junior engineer, and there had recently been a marked increase in the number of senior engineers joining the Association. The balance sheet showed the Association to be in a healthy financial condition.

On account of his leaving Battersea to take up a new appointment, it was regretted that Mr. Healy, to whose energy the Association owes its present flourishing condition, had found it necessary to resign.

New officers were nominated, and the following were elected: President Mr. A. C. Bostel (Croydon); vice-president, Mr. W. J. Jeffery (Charing Cross, West End & City Electric Supply Co.); hon. secretary and treasurer, Mr. W. A. Jones (37, Wallwood-road, Leytonstone, E. 11); publicity secretary, Mr. G. C. Law (Barnes).

The Committee consists of Messrs. Chapman (L. & N.W. Railway Co.), Christmas (Islington), Clare (Woolwich), Ciffen (West Ham), Healy (Battersea), Hewitt (Charing Cross, West End & City Electric Co.), Mann (City and South London Railway Co.), and Wilcocks (Hammersmith).

A presentation was made to Mr. W. A. Jones for his ungrudging efforts on behalf of the Association, and at the close of the general meeting a few members presented cigarette cases to Messrs. Healy and Jones in appreciation of their services.

On Feb. 6 a meeting of Hull Electrical Station Engineers was held under the chairmanship of Mr. Shankster (acting chief assistant at Sculcoates-lane). The following resolution was passed unanimously: "That this meeting of Hull electrical station engineers, having in view the period of industrial and economic reconstruction after the war as freshadowed in the Whitley report, and in that of the Coal Conservation Sub-committee, considers that the interests of their profession can only be effectively represented by a powerful and united body elected from and by all grades of station engineers; this can, in its opinion, be best attained by all central station engineers becoming members of the A.E.S.E."

The persons present unanimously decided to form a local branch of the A.E.S.E., and in the meantime to apply to be attached to the Manchester branch.

Bootle.—Last week the Electric Power and Lighting Committee submitted proposals to the Council for an agreement with Liverpool Corporation in regard to a bulk supply of electricity.

The proposals included the interconnection of the electricity undertakings of the two corporations. The Ministry of Munitions proposed this as an alternative to the provision of additional plant at Bootle. The agreement provides that the period of the agreement shall be three years instead of seven, terminable by one year's previous notice in [illegible] of Bootle being able to obtain more favourable terms [illegible] supply from other parties. The demand which must be met [illegible] Liverpool Corporation must be 3,000 kw. from the commencement of supply, instead of 1,500 kw. The tramway supply of electricity to [illegible] by Bootle. The supply to be measured at Bootle and Liverpool boundaries in premises to be provided at the joint cost of the Corporations. Bootle will run its plant in commission at the peak [illegible] to be installed by Bootle during the three [illegible]

[illegible] amendment was carried, making it [illegible] Bootle be able to obtain more favourable [illegible] in the event of [illegible] period.

[illegible] further consideration of the [illegible]

Carlisle.—[illegible] Tuesday the Council granted [illegible] from [illegible] April [illegible] with two further annual [illegible] to be discontinued [illegible] from £210 [illegible]

[illegible]

Dublin.—[illegible]

Electrical Power Engineers' Association.—A national conference of the Association of Electrical Station Engineers was held on the 11th inst., at St. Bride Institute, London. The President of the National Association (Mr. W. A. Jones) was in the chair, and the following were present:—

Messrs. Alldridge, Bostel, Bradley, Chapman, Christmas, Giffen, Healy, Hildebrand, Jeffery, Law and Wilcocks (London); A. O. Holt and W. Thomas (Manchester); F. Langley (Sheffield); and Messrs. W. H. Bowser, F. W. Brittain and R. F. Burgess (from the Midland Electric Power Supply Engineers' Association). A telegram was received from staff engineers in Bradford assuring the Association of their hearty support in the Reconstruction.

Sections.—It was agreed that three centres be fixed—Manchester, Birmingham and London, each to control the affairs of their sections in the areas as under: (1) Manchester.—The area North of Nottingham, Chester and Stoke, including North Wales. (2) Birmingham.—South of above line and North of Gloucester, Northampton and Peterborough, including South Wales. (3) London.—South of Gloucester, Northampton and Peterborough.

Title of Association.—It was proposed by Mr. Thomas (Manchester) and seconded by Mr. Burgess (Birmingham), that the title of the National Association be altered to the Electrical Power Engineers' Association.

Legal Status.—After the question had been thoroughly debated it was decided that having carefully examined the question of registration or incorporation, this meeting, acting upon legal advice, resolve that the Association shall operate under registration.

Qualification for Membership.—It was decided that the Selection Committees be instructed to maintain the existing high standard of qualifications, and that qualified engineers in charge of power plant in factories be eligible for membership.

The National Executive Council will comprise the president, secretary and two nominees from each of the divisions.

Rules.—The Section Committees are to submit their proposals concerning the revision of rules to the National Executive Council for final consideration.

The resignation of the National secretary (Mr. W. J. Ebben) was received with regret, and a sub-committee was appointed to arrange for some recognition of the services rendered by Mr. Ebben in the pioneer work of the original Association. Meanwhile Mr. Jones agreed to act until the appointment has been filled by the National Executive Council.

Electrical Trades Benevolent Institution.—The claims of this Institution were brought before the Conference, and it was decided that it was deserving of the whole-hearted support of the members and that particulars and applications for membership be supplied to each section. It was felt that the good work done among staff members of the electrical industry and their dependents was such as demanded the help of the members of the Electrical Power Engineers' Association.

Electricity v. Gas.—At the ordinary general meeting of the Gas Light & Coke Co. on Friday last, the governor (Mr. John Miles), who presided, said that, as many of them were aware, the question of the future supply of electricity in this country was being made the subject of inquiry by several Government Committees. The matter was being watched by the directors. They were of opinion that there was no reason why there should not be co-operation between the gas and electricity industries, and they believed that such co-operation would be very much to the benefit of the public.

Hackney (London).—The Electricity Committee report that, owing to the recent wages awards by the Government to the electrical and mechanical engineering trades, the cost of generation and distribution will be considerably increased.

The Committee find it difficult to gauge their present financial position, and impossible to predict what further trouble they will have to face next year. Therefore they consider it prudent to raise the pre-war prices for current as from the March quarter readings by 50 per cent., as against the present 30 per cent. on light and 40 per cent. on power. Slot meter consumers are to be charged the same minimum as flat rate consumers (11s. 3d.), and the price is to be fixed at 8d. per unit.

Londonderry.—At a meeting of the city council last week a resolution in favour of the Corporation Improvements Bill, which authorises the supply of electricity and water to a new shipyard, was approved.

Rawtenstall.—The L.G. Board is to be asked for consent to a loan of £[illegible],400 for new plant for the Corporation's electricity works.

Yorkshire Electric Power Bill.—A conference of representatives of West Riding local authorities was held on Monday to consider certain questions [illegible] out of this Bill.

[illegible] taken by Ald. E. J. Crossley, chairman of the West Riding Law and Parliamentary Committee, and Mr. A. G. Lupton, [illegible] of the Yorkshire Electric Power Co., attended and explained [illegible] of the Bill.

After [illegible] Mr. [illegible] Newstead, clerk to the Wharfedale Rural [illegible] proposed, and the meeting adopted the following resolution: [illegible] of opinion that the Bill now being promoted by the Yorkshire Electric Power Co. unduly prejudices the rights [illegible] within the area of supply, and recommends that the Bill be opposed."

At [illegible] meeting of [illegible] Council on Monday it was decided [illegible] the Bill.

Electric Traction.

Belfast.—For the nine months ended December last the Corporation tramways show a surplus profit of £7,048 (against £5,123 for the corresponding period of 1916). Receipts were £260,000 (£229,500) and passengers increased by 2½ millions.

Councillor J. C. White has been elected chairman and Councillor J. A. Duff vice-chairman of the Tramways and Electricity Committee.

Blackpool.—At the meeting of the Tramways Committee on Monday, the general manager (Mr. Charles Furness) reported that the total receipts since April 1 had passed the £100,000 mark. Never before have the receipts reached six figures in 12 months. The previous record was last year's—£94,000.

Bradford.—A tramcar accident occurred at Allerton on Friday last, r sulting in the drive: being killed and several persons being injured. The car was going down a steep incline when the brake failed to act.

Carlisle.—On Tuesday the Council decided that having regard to the alleged unsatisfactory condition of the tramway system and service, the General Purposes Committee be asked to take the question into serious consideration, with a view to some definite action being taken.

Electric Vehicle Progress.—Oldham and Bootle Corporations have recently placed orders with the Electromobile (Leeds), Ltd., for the supply of a 2 ton and a 3½ ton chassis for electric tipping wagons.

The annual report of the superintendent of the cleansing department of Glasgow Corporation gives some figures of the actual running cost of the fleet of mechanical vehicles employed. The fleet is composed of 17 machines in all, one of which is a traction engine. Two 3 ton petrol-driven vehicles, as well as two 2-ton Edison electrics, are employed for the house-to-house refuse collection. It is pointed out that the former vehicles, although advantageous in some respects, notably in effecting the rapid transit of material to the destructor works, cost more than horse haulage, due mainly to the numerous stoppages. The electrics, which have not been in operation any great length of time, are fulfilling expectations. The cost of each type per ton of material hauled, as compared with horse haulage, is as follows: For electric vehicles, 2s. 10.65d.; for petrol machines, 3s. 9.52d.; for horse haulage, 3s. 3.15d.

Miscellaneous.

Electro-Harmonic Society.—The next concert (Ladies' Night) will take place at the Holborn Restaurant this Friday evening, at 6.15 p.m., with Mr. Ll. B. Atkinson in the chair.

Italian Wireless Telegraphy.—An Italian radiotelegraph station has been erected which can send messages to the station at Arlington, Virginia, a distance of 6,250 miles.

Tenders Invited.

Railway Stores.

The GREAT CENTRAL RAILWAY CO. are prepared to receive tenders for the supply during the six months ending Oct. 31, 1918, or during the 12 months ending April 30, 1919, of various Stores and Materials, including Asbestos Packing, Sheets and Boiler Covering, Colours and Mixed Paints, Gas, Water and Steam Tubes and Fittings, Glass, Hardware, Indiarubber, Iron Bars, Chains and Slings, Lamps and Lamp Fittings, Nails, Oil, Screws, Signal Materials, Steel Castings, &c. Samples and patterns may be seen from Feb. 25 to March 4 inclusive, in the Public Hall of the Conservative Club, Gorton-lane, Gorton, Manchester. Further particulars are given in an advertisement, and tenders must be in the hands of the secretary, Mr. J. A. Campbell, Marylebone Station, London, N.W., by [illegible] a.m., Tuesday, March [illegible]. *See an advertisement.*

Turbo-Alternator and Condensing Plant.

The Corporation of the County Borough of Newport (Mon.) invite tenders for section 1, 3,000 kw. turbo-alternator, and section 2, surface condensing plant for 3,000 kw. turbo-alternator. Form of tender, &c., from Mr. A. Nichols Moore, M.I.E.E., borough electrical and tramways engineer, Town Hall, Newport, Mon. Tenders by 10 a.m. Feb. 18 to Mr. Albert A. Newman, town clerk.

Tramcar Wheel Tyres.

[illegible]

Tramway Stores.

[illegible]

Copper Conductor, &c.

[illegible]

Appointments Vacant and Filled.

The Council of the Metropolitan Borough of Hammersmith invite applications for the positions of meter superintendent (salary £160, rising to £175 per annum), and engineer-in-charge (salary £175, rising to £200 per annum). Applications to the Borough Electrical Engineer, 85, Fulham Palace-road, W.C., by Thursday, Feb. 21. *See an advertisement.*

Liverpool City Council invite applications for the appointment of deputy-general manager of the tramways undertaking. Salary £800 per annum. Applications to the Town Clerk, Municipal Offices, Liverpool, by 5 p.m., Feb. 20. *See also an advertisement.*

A teacher is required to give lecture and laboratory instruction in the applied electricity classes at the Birmingham Municipal Technical School. Particulars from the Secretary, Suffolk-street, Birmingham. *See advertisement.*

A London supply authority requires a meter test room assistant. Wages 35s. 12½ per cent. bonus. *See advertisement.*

The Guardians of the Ormskirk Union require an electrical engineer. Salary £2. 5s. per week plus war bonus. Applications to the clerk (Mr. Alfred Dickinson), 2, Railway-road, Ormskirk, by Feb. 20. *See advertisement.*

A junior shift engineer is required for large power station in the north. *See advertisement.*

A test-room superintendent is required for a Corporation electricity department in the north of England. Salary £225 per annum. *See an advertisement.*

A power-house superintendent is required for a Corporation electrician department in the north of England. Salary £350 per annum *See an advertisement.*

Barrow-in-Furness Education Authority invite applications for the position of Principal of their Technical School. Salary £400 per annum. Particulars from the Director of Education, to whom applications by Feb. 18.

A commercial assistant is required in the electrical engineer's department of the County Borough of Stoke-on-Trent. Salary £220 per annum. Particulars from the Borough Electrical Engineer.

Instrument makers and skilled mechanics are required for a shore establishment on the South Coast.

The King has approved of the appointment of Sir Joseph Thomson, O.M., D.Sc., F.R.S., Master of Trinity College, Cambridge.

A commercial assistant is required for the Stoke-on-Trent electrical engineer's department. Salary £220 per annum. Particulars from the Borough Electrical Engineer.

A senior lecturer in electrical engineering is required for the Portsmouth Municipal College. Salary £200, rising to £250 by £10 annual increments. A workshop instructor in electrical engineering is also required at the College. Forms of application from the Secretary, Mr. H. E. Curtis.

Mr. B. L. Meek has been appointed city engineer of Manchester, at a salary of £1,000 a year.

Business Items.

Messrs. T. W. Broadbent (Ltd.), Huddersfield, have arranged with Mr. James Espie, 36 to 38, Smith-street, Kinning Park, Glasgow, to act as their agent in Scotland for the sale of their [illegible] switchboards, &c., and he will in future deal with all Scottish [illegible].

ARC LAMP CARBONS.—The General Electric Co. [illegible] Queen Victoria-street, London, E.C. 4, [illegible] containing price lists of the company's [illegible].

[illegible]

Sale by Auction. [illegible] States."

Patent Development. [illegible]

Plant Wanted. [illegible]

Plant for Sale. [illegible]

Companies' Meetings and Reports.

DUBLIN UNITED TRAMWAYS CO. (LTD.)—In moving the adoption of the report at the annual meeting last week, the chairman (Mr. W. M. Murphy) said the capital expended during the past year only amounted to £2,367. Compared with 1916 the revenue showed a remarkable expansion, but so did the expenditure. The gross receipts had increased in the five years from 1912 to 1917 by £51,106, but the working expenses had increased £76,503. They had hitherto refrained from raising fares, but action in that respect could not be long delayed. In regard to the supply of electricity to the Alexandra Docks he had received a letter from the Ministry of Munitions stating that it was probable the Admiralty, acting on the advice of the Department, would send a formal letter to provide the supply of current urgently required at the yard of the Dublin Dockyard Co. That, said the chairman, was taken up by the general manager (Mr. Harriss) and he saw the engineer to the electricity department of the Corporation, who stated that they had ample spare power to supply the Dockyard and military authorities. That was to say the Ministry of Munitions could get the supply from the Corporation, and that it would not be necessary to take it from the company. A reply followed from the Ministry of Munitions saying they had information that the Corporation could not supply them, and with the letter was sent a notice under the Defence of the Realm Act ordering the tramway company to supply the Dockyard with electricity. The company did not want to give the supply, and if the Corporation were able they were at liberty to do so.

KALGOORLIE ELECTRIC POWER & LIGHTING CORPN. (LTD.)—In a circular to the shareholders it is stated that owing to the disorganisation caused by the war, particularly to the mail service, it is anticipated that the accounts for the past year will not be received from Australia early enough to permit of the issue of the directors' report and balance-sheet and the holding of the general meeting at the usual time in May. From the mails that have arrived, and from later information received by cable, it is calculated that the net income of the past year will be nearly £4,000 below that received in 1916. This large decrease is mainly due to the shortage and the refractory attitude of labour, which, with other causes, prevented the mines from producing the usual tonnage of ore, thereby lessening the demand for electric current. There has also been a further increase in the cost of all supplies. These disadvantages have been most markedly conspicuous during the last quarter of the year, the cabled returns indicating a reduction in receipts of some £1,400 compared with the corresponding period of the previous year. In view of the smaller profit and of the arrangement entered into with the debenture holders to appropriate the first profits made during the year, to the amount of £7,500, for a further repayment to them, the directors have decided that they will not be justified in paying the usual dividend to the preference shareholders in April next. The debenture debt has now been reduced to £30,000.

LLANDUDNO & COLWYN BAY ELECTRIC RAILWAY (LTD.)—The profit for the year ended Nov. 30, 1917, after providing for ordinary operation and administration expenses and debenture interest, &c., amounts to £4,716, compared with £5,317 in 1916. The net results have been affected by the continued difficulties and increased cost of obtaining labour and materials, and by the great decrease of holiday traffic in consequence of increased railway fares and restrictions of travelling facilities. The profit, together with £158 11s. 6d. brought forward, amounts to £4,874, of which there has been applied in providing for the [illegible] fund instalment due Jan. 1, 1918, £1,695, leaving £3,178 14s. 7d. The directors recommend the payment of a dividend at the rate of 5 per cent. per annum (£2,982), leaving to be carried forward £196 14s. 7d.

NORTH LONDON RAILWAY CO.—The directors have, after placing £10,000 to general reserve, declared a final dividend to Dec. 31 last of £1 15s. per cent. on the consolidated ordinary stock, making £3. 15s. per cent. for the year, and carrying forward about £10,600.

ST. JAMES & PALL MALL ELECTRIC LIGHT CO. (LTD.)—The directors recommend a balance dividend on the 7 per cent. preference shares for the half-year ending Dec. 31, 1917, of 3s. 6d. per share and [illegible] per share on the ordinary shares, making, with the interim dividend already paid, 7 per cent. and 9 per cent. for the year.

The transfer books of the Company will be closed from the [illegible] to [illegible], preparatory to the payment of dividends for the half-year ended Dec. 31.

City Notes.

CENTRAL LONDON RAILWAY CO.—The directors have declared a dividend [illegible] months ended Dec. 31 [illegible] per cent. [illegible] on the preferred [illegible] per cent. [illegible] and on the [illegible] £11,117 to be carried forward.

CITY & SOUTH LONDON RAILWAY CO.—The directors recommend a dividend [illegible] months ended Dec. 31 [illegible] per cent. [illegible] per cent., carrying [illegible] forward.

LONDON ELECTRIC RAILWAY CO.—The directors recommend a dividend [illegible] per cent. [illegible] for the past [illegible] Dec. 31, 1917, [illegible] per cent. [illegible] forward.

LONDON & SUBURBAN TRACTION CO. (LTD.)—The directors notify the preference shareholders that, owing to the depletion of the staff, the accounts for the past year cannot be completed prior to the 15th inst., when the dividend on the preference shares is due. A notice will be issued as soon as possible after that date announcing the decision of the directors in regard to the payment of a dividend upon the preference shares on account of the year 1917.

MATHER & PLATT (LTD.)—The directors recommend a dividend of 12½ per cent., making 17½ per cent. for the year, on the ordinary shares (the same rate as for 1916).

METROPOLITAN DISTRICT RAILWAY CO.—The directors recommend dividends making for the year 4 per cent. on the 4 per cent. guaranteed stock, 4½ per cent. on the 4½ per cent. first preference stock, and on the 5 per cent. second preference stock for the six months ended Dec. 31, 1917, 1½ per cent. (making for the year 3 per cent.), and carrying £29,029 forward.

NEWCASTLE-ON-TYNE ELECTRIC SUPPLY CO. (LTD.)—A final dividend of 5½ per cent. on the ordinary shares, making 8 per cent. for the year, has been declared (compared with 4½ per cent. and 7 per cent. respectively, last year).

TELEGRAPH CONSTRUCTION & MAINTENANCE CO. (LTD.)—The directors have decided, subject to audit, to distribute, in addition to the interim dividends of 5 per cent. paid in July last, a further dividend of 10 per cent., together with a bonus of 12s. per share.

The transfer books of the Company will be closed from 18th to 28th inst., inclusive, preparatory to payment of dividend.

UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON (LTD.)—The directors state that, subject to final audit, the revenue will enable them to pay the full interest to Dec. 31 last on the 6 per cent. first cumulative income debenture stock, and to pay 2 per cent. (tax free) on the 6 per cent. income bonds of 1948 for the half-year ended Dec. 31 (making 4 per cent. for year), with a carry forward of about £31,000.

The Round Table.

By "kVA."

EVENT OF THE WEEK.—"The Gas World" goes up to 6d., and thereby pays us a pretty little compliment.

* * * *

MOTTO OF THE MOMENT.—Work like Helen B Merry. (I'm doing my best.)

* * * *

A friend tells me that in the course of his business he receives so many duplicate forms from Government Departments that he makes a quite useful amount out of them as waste paper. (Make a note of it!)

* * * *

This week's Chestnut. It is stated that a Scottish marine engineer has successfully camouflaged a number of vessels of which he has charge. The hulls have painted on them a number of Scotch jokes, with the result that the U-boat commanders cannot see them, of course!

* * * *

"The Star" says: "Henley has decided to start a municipal piggery. Why not begin with a Henley hennery?"

I quite agree; Henley's have been laying cables all these years, and eggs would be a nice little change just now, and each little egg might appropriately be stamped Henley's, Member of the Egg Layers' Association"!

* * * *

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, Feb. 12, 1881.]

TELEPHONE AT DARLINGTON. A lecture on the telephone was given here lately by the Rev. Mr. Hunnings. Having explained the nature of the instrument to the audience, the lecturer left the hall and proceeded to an office some distance away, from which he addressed them, his voice being distinctly heard. Mr Hunnings concluded by a description of the photophone.

PLACE AUX DAMES. Following in the footsteps of the sterner sex, we find the female clerks of the Central London Telegraph Office are imitating their brothers, and petitioning to be put on the same footing as the female clerks of the Savings Bank and Telegraph Message Departments. We have no doubt that if they are like the rest of their sex they will gain their end, let the Postmaster General harden his heart never so much.

AN ELECTRIC HEADLIGHT FOR LOCOMOTIVES. An electric head light for locomotives will soon be tried on the Cleveland and Pittsburg Railroad. The power will be furnished by a small engine placed behind the smoke stack, and furnished with steam from the main boiler. It seems to us that electric headlights are always going to be tried. It is about time that American locomotive superintendents—we beg pardon, master mechanics—began. The electric headlight is just the thing for unfenced railways.—"Engineer."

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CONTENTS.

Notes.

Industrial Management.

AMONG the many subjects of increasing importance to those engaged in industrial undertakings must be classed that of industrial management. Hitherto men have gone into work with no preconceived notions of the subject. They have grown up with it, as it were, have formed their own opinions, and have gradually evolved their own methods. It does not follow, however, that this is by any means the best plan to follow; in fact, it is fairly obvious that the man who starts with a certain general knowledge of principles and practices commonly adopted, provided his views are not too academic, will be in a better position to look after works than the man who starts with no such knowledge. This view of the matter has evidently taken root at Manchester, for we have now received particulars of a new development at the Manchester School of Technology in the shape of a lectureship in industrial management. For some little time short courses of lectures on management, costing and economics have formed part of the university courses taken by candidates for the degree of B.Sc.Tech. at Manchester University, whether in engineering, applied chemistry or textile technology. Now, however, it is felt that something more substantial should be done in this direction, and with this end in view a group of large firms engaged in the principal industries in the Manchester district have offered the governing body of the School of Technology the sum of £3,000, spread over a period of five years, towards the cost of establishing a new department of industrial management. This gift has been accepted by the Manchester Education Committee, and it is proposed to appoint a lecturer in the subject for a period of five years. As in all such cases, the difficulty is to keep thoroughly up to date in a subject that is far from being standardised. In the present instance, in order to keep the department in close touch with practice, a number of managers, directors, efficiency experts and others who have had special experience or who are responsible for important innovations, will be invited to deliver public lectures, being offered substantial fees which will not only pay them for placing their knowledge at the disposal of their fellow managers, but will serve to encourage enterprise and experiment in matters connected with management. This step marks what we hope is the beginning of a new development in more scientific methods, and the end of those secretive methods of conducting business based on the idea that each manufacturer knows far better than his neighbour. The dissemination of knowledge in regard to management will do far more good than the working out of policies in secret. Other universities in industrial centres will do well to watch this new experiment at Manchester.

Co-operation Among Technical Societies.

AMONG English technical societies there has always been a tendency, as in industrial firms, to avoid serious co-operation, though occasionally joint meetings have been held. Such meetings, however, form a very minor kind of co-operation. Since the war there has been a greater disposition to pull together, as is evident in the formation of the Board of Scientific Societies by the Royal Society. This is a step in the right direction, but it covers only a limited part of the field. From some translations which have been made by Sir ROBERT HADFIELD, we notice that in Germany the technical societies have gone a step further, and it is clear that they see the importance of dealing with certain questions in a co-operative manner. It appears that 13 German technical and scientific societies have formed a union, the object of which is to establish a better balance between science and practice. A committee has been formed to act as an intermediary between the technical world and the scientific institutions of the universities and the technical academies for the carrying out of technical research. It is pointed out that here and there specialised knowledge is to be found of a valuable kind, and that if problems can be directed to persons possessing such specialised knowledge there is a material advantage, the greatest progress being thus made with a minimum of labour. The view is taken that even in large industrial establishments it might sometimes be not undesirable to come into touch with academic persons who would be willing to consider complicated questions from the scientific standpoint without disregarding technics. Consequently industrial works engaged in chemistry, applied physics, electrotechnics, machinery construction and engineering science in general are requested to address enquiries to the Committee.

Some Wider Objects.

APART from this phase of work the union has many objects, such as the admission of academically trained technicians to all administrative departments of the Federal States—in other words, the greater recognition of science by public bodies. It is pointed out that technical science has helped during the war in three ways, namely, in providing raw materials formerly obtained from abroad, in increasing the use of waste products, and in producing substitutes, such as synthetic products. There appears to be some uneasiness as to the multiplicity of Government authorities controlling

construction, as these, in the opinion of the union, had prejudiced German products in peace times. Evidently this is a recognition of the over-organisation which we believe is a difficulty in Germany, as it leads to lack of elasticity. It is also interesting to note that a steady movement of prices is advocated by having strictly organised syndicates, so that remunerative conditions will be obtained, favourable to technical science, with consequent brisk investment. We need have no delusions in this country that Germany intends after the war that her industrial firms shall be run on such a basis that they will be paying concerns and prove attractive to the investor. That is a prime essential, which, unfortunately, has not always been realised in this country.

The Yorkshire Electric Power Co.

At the annual general meeting of the Yorkshire Electric Power Co., the Chairman, Mr. A. G. LUPTON, gave an interesting account of the progress made by the Company since powers were obtained in 1901. The station at Thornhill was built in 1904 and the total plant (including that at Barugh) now amounts to 31,000 kw. with 358 miles of mains running over a [illegible] area. The network covers 91 separate districts, with 120 sub-stations. Only those who are responsible for power companies in this country know the uphill task that has been involved. In the early years it was necessary to [illegible] scattered consumers who could not otherwise be supplied, the most remunerative consumers being in towns which the Power Company was not allowed to touch. Local authorities, generally speaking, were quite averse to taking a bulk supply; and owing to the comparatively small amount of capital of the Power Company to start with, no [illegible] could be offered. Thus progress was slow, and in the case of the Yorkshire Company no dividends were paid on the ordinary shares until 1914, when a dividend of 1 per cent. was declared, and during the past year the dividend has risen to 5 per cent. The Power Company has been handicapped to some extent by the fact that it possessed no powers to supply current for lighting except in connection with power. This difficulty was overcome by forming an allied company (the Electrical Distribution of Yorkshire, Ltd.), which now holds lighting Orders in 24 areas. The business in this direction has been increasing considerably, and many of the smaller local authorities have seen the desirability of either allowing their Orders to lapse or of transferring them to the Company. Moreover seven local authorities and one company are now taking a bulk supply from the Power Company. That an important need is being met is proved by the fact that the Government has made financial arrangements with the Company to enable them to carry out extensions. The directors are to be congratulated upon seeing success, though long deferred, as the fruit of their labours.

Industrial Reconstruction.

We are glad to note that the first meeting of the Industrial Reconstruction Council which was held at the London Guildhall on Friday was supported enthusiastically, and that there is evidently a general appreciation of the importance of Joint Industrial Councils. There is no doubt that responsible labour leaders appreciate fully the advantages of Capital and Labour coming together to discuss matters in which they have an equally vital interest. Mr. G. H. Roberts, Minister for Labour, supported the feeling of the meeting. On the other hand Mr. [illegible] struck a [illegible] note in reference to the [illegible] of [illegible]. We do not know what [illegible] may have been in the past, but it is clear that "[illegible]" conditions cannot be tolerated in the future, and, if there are such, they can certainly be brought to an end much more readily by joint councils than by any other way. It is only by such means that better conditions can be promoted quickly and smoothly.

Optical Society. — Prof. Frederic J. Cheshire, C.B.E., Director of the Department of Technical Optics at the Imperial College of Science and Technology, has been elected President of this society.

The Paper Situation.—It is only natural that force of circumstances should impress upon those responsible for conducting journals the seriousness of the present shortage of paper. We would impress upon our readers the desirability of saving all waste paper, for which good prices are obtainable at the present time.

Patents and Designs Bill.—Members of the Institution of Electrical Engineers interested in the above are invited to be present at a private and informal meeting, which will be held in the Lecture Theatre of the Institution of Civil Engineers, on Thursday, Feb. 28, 1918, at 2.30 p.m., for the purpose of discussing the provisions of the Bill, &c. Copies of the Bill can be obtained from H.M. Stationery Office, Imperial House, Kingsway, W.C., at the price of 3d. net each.

Physical Society.—At the last meeting of the Society the following officers and Council were elected :—

President: Prof. C. H. Lees, D.Sc., F.R.S. *Vice-Presidents:* Prof. J. W. Nicholson, M.A., D.Sc., F.R.S., Prof. O. W. Richardson, M.A., D.Sc., F.R.S., S. W. J. Smith, M.A., D.Sc., F.R.S., W. E. Sumpner, D.Sc. *Secretaries:* W. Eccles, D.Sc., R. S. Willows, M.A., D.Sc. *Foreign Secretary:* Sir R. T. Glazebrook, C.B., D.Sc., F.R.S. *Treasurer:* W. R. Cooper, M.A., B.Sc. *Librarian:* S. W. J. Smith, M.A., D.Sc., F.R.S. *Other Members of Council:* H. S. Allen, M.A., D.Sc., Prof. E. H. Barton, D.Sc., F.R.S., C. R. Darling, F.I.C., Prof. G. W. O. Howe, D.Sc., D. Owen, D.Sc., C. C. Paterson, C. E. S. Phillips, F.R.S.E., S. Russ, M.A., D.Sc., T. Smith, B.A., F. J. W. Whipple, M.A. The President announced that Dr. R. S. Willows, M.A., was resigning his secretaryship, on leaving London for a post in the North. The Council had appointed Dr. H. Stanley Allen, M.A., in his place.

The Institute of Radio-Engineers.—The Institute of Radio Engineers in New York is evidently one of those fortunate bodies which have enjoyed added prosperity since the outbreak of war. According to the "Year Book" for 1916, just issued, the membership has grown from 109 in 1913 to 984 in 1916, and is apparently still increasing—a convincing testimony to the importance wireless telegraphy has assumed since the war began. We note that a Committee on standardisation is engaged on the attempt to secure uniformity of symbols, methods of rating and testing, &c., in connection with wireless work. Reference is also made to the important Convention held at the Panama Pacific Exhibition in 1915.

Electro-Culture Committee.—The President of the Board of Agriculture and Fisheries has appointed a Committee to advise in regard to all electrical questions in connection with the carrying out of experiments in electro-culture, and particularly in regard to the construction of apparatus suitable for use on an economic scale, and to the making of such electrical measurements as may be necessary in connection with the experiments.

The Committee is constituted as follows: Sir John Snell (chairman); Mr. A. B. Bruce; Prof. V. H. Blackman, F.R.S.; Dr. C. Chree, F.R.S.; Mr. W. R. Cooper; Dr. W. H. Eccles; Mr. J. S. Highfield; Prof. T. Mather, F.R.S.; Dr. E. J. Russell, F.R.S.; and Mr. C. T. R. Wilson, F.R.S. Mr. B. W. Phillips, of the Board of Agriculture and Fisheries, will act as secretary to the Committee, and all communications should be addressed to him at 4, Whitehall place, S.W. 1.

A Recording Thermometer. At the last meeting of the Physical Society Prof. C. V. Boys described a recording thermometer. This instrument is designed and constructed to go into the case of a regulator clock. The thermometric element consists of a rod of ebonite within a glass tube. The differential expansion is determined by a pair of levers giving a movement of 1 in. for 10° F. The drum carries an ordinary barometer chart and is driven at such a speed that a two hour interval of ½ in. is passed in 24 hours. The drum is driven by

friction by means of a cord from below the driving weight of the clock by an $e\mu^{\theta}$ arrangement, in virtue of which when the clockweight descends the drum turns, but when the clock is wound the drum remains at rest. The instrument is designed with a view to easy construction and accuracy. It is extremely rigid, and much more magnification might be used. An alternative design on the same lines to go into a recording baragraph is also given.

The Institution of Mechanical Engineers.—The annual report of the Council of the Institution of Mechanical Engineers for 1917, shows an increased membership, and refers to various important researches being undertaken by the Institution. Honours have fallen to a number of members, among which may be mentioned the granting of a Baronetcy to Sir Robert Hadfield (vice-president), while Mr. George Carter, Dr. Dugald Clerk, and Sir Vincent L. Raven have been created Knights Commander of the Order of the British Empire. Over 1,000 members are, or have been, on active service. The Institution is taking steps to assist members to find suitable employment on return to civil life. Grants have been made by the Council for research on alloys, steam nozzles, hardness tests and wire ropes. It is proposed to devote the gift of £500 from Mr. Richard Williamson in aid of engineering research, to "A Research to determine the best form and material for Pistons and Piston-Rings, especially for Internal-Combustion Engines."

Institution of Electrical Engineers.—SCOTTISH LOCAL SECTION.—At the last meeting of the Scottish Local Section, held at Glasgow, Mr. A. Page presided over a crowded attendance of members and friends. He remarked that they had with them Mr. Wordingham, the president, and Mr. Rowell, secretary of the Institution, and they had also Col. Malcolm, the only surviving member of the genesis of the Institution. He called on Col. Malcolm to address them.

Col. MALCOLM said that a brother officer of his, the late Major-General C. E. Webber, while in charge of some telegraph scopes in London made the acquaintance of Sir William Siemens, and they spoke together about forming an institution for electrical engineers. General Webber said to him "Will you join?" and when he said he would, General Webber replied "That is the three [illegible]" [illegible] speaker) met with much opposition in his objection to the admission of female telegraph operators as members of the Institution, which was mainly advocated because they were in want of money at that time. He gained his point, and so kept the Institution on its own proper line of development. Now it was one of the most important [illegible] institutions in the world.

Mr. WORDINGHAM, after referring to the industrial and commercial fame of Glasgow, spoke of the work which had been done in Glasgow in the manufacture of measuring instruments for electrical energy. He said that the electric propulsion of ships owed much to the pioneering experiments of the late Mr. Henry Mavor, who had been consulted by the United States Government's contractors in connection with their scheme for the electric propulsion of battleships. He advocated development of joint action on the part of engineering institutions through the formation of a local engineers' club. For 18 months they had been working on a set of rules governing the equipment of ships, and excellent assistance had been given by Messrs. Lowson, Henderson, Nielson, Stewart and others members of the Scottish Section. He hoped that these rules before being finally adopted would be submitted for amendment or approval to the whole body of the members of the various local sections. In research work they were working in union with the B.E.A.M.A. The amendment of the Patent Law was receiving attention in view of the Bill before Parliament dealing with that matter. He hoped that the suggested Electrical Proving House for British manufactures would take practical shape before long. The application of electricity to medical treatment was likely to receive increased attention from the Institution, and a joint meeting with the medical authorities had been arranged. He advocated the provision of increased means for social intercourse amongst the members, particularly a little dinner after the meetings. He indicated possible lines of development for the Institution "Journal," which he was afraid many at present did not open.

Dr. MACLEAN then repeated his Kelvin Lecture which he delivered before the Institution in London.

Obituary.

DEATHS ON ACTIVE SERVICE.—The following deaths have been reported:—

Capt. and Adjutant Arthur P. Marshall, [illegible], 28 years of age, who died on Feb. 2 from [illegible] received on Dec. 8 [illegible] engineering training at Manchester University, and subsequently took the Mechanical Science Tripos at Cambridge, and was appointed to Messrs. [illegible] & [illegible]. He enlisted [illegible] on the outbreak of war.

Wireless Operator H. [illegible], who was killed on Friday last, was formerly an apprentice to Messrs. [illegible] Wood & Co., Ltd., [illegible] Salford, and a student at the Royal Technical Institute, Salford, where he obtained a certificate for practical higher mathematics. He also took the City & Guilds certificate for structural engineering.

Pte. Geo. Hyhams (London Regt.), formerly in the special sales department of the India Rubber Co., has died of wounds in Egypt.

Personal.

Mr. J. H. Sandiford has resigned his position in the switchgear department of Messrs. Ferranti (Ltd.), in order to take up an appointment with Messrs. Ferguson, Pailin & Co. as their engineer and representative for the London district. A presentation of an electroplated tea set was made by Mr. J. Denham, the manager of the department, on behalf of the members of the staff.

MILITARY APPOINTMENTS.—The following have been appointed Acting Captains in No. 3 Wireless Signal Squadron of the Indian Army:—

Lieut. F. J. Foxlee (Indian Army Reserve of Officers), Lieut. B. M. Peek (1/7th Battalion Hampshire Regiment), Sec.-Lieut. R. A. E. Blake (1/6th Battalion Hampshire Regiment), Sec.-Lieut. B. Mead (2/7th Battalion Hampshire Regiment).

WAR HONOURS.—The following honours have been conferred:—

Bombr. F. A. Hirst (R.F.A.) has been awarded the D.C.M. He was formerly an electrician in the Blackpool Corporation tramways department.

Lieut. D. S. Baddeley (A.S.C., M.T.) has been awarded the Belgian Croix de Guerre and the Order of the Crown of Belgium. He was formerly engaged as a representative of Crompton & Co.

WAR CASUALTIES.—The following casualties are reported:—

Sec.-Lieut. C. A. Robertson, son of Mr. J. A. Robertson, Borough Electrical Engineer of Salford, who was reported missing on Nov. 30 last, is now reported a prisoner of war in Germany and slightly wounded.

Pte. H. Fennel (Middlesex Regt.), formerly engaged in the India Rubber Co.'s experimental department, was wounded recently.

Arrangements for the Week.

FRIDAY, Feb. 22nd (to-day).

PHYSICAL SOCIETY.

5 p.m. At the Imperial College of Science, Imperial Institute-road, S. Kensington, London, S.W. Papers on "Note on the Use of Approximate Methods in Obtaining Constructional Data for Telescopic Objectives," by Mr. T. Smith, B.A., and "A Suggestion as to the Origin of Spectral Series," by Dr. H. Stanley Allen, M.A.

SATURDAY, Feb. 23rd.

ROYAL INSTITUTION.

3 p.m. At Albemarle-street, Piccadilly, London, W. 1. Lecture on "Problems in Atomic Structure," by Prof. Sir J. J. Thomson, F.R.S. (Lecture II.)

MONDAY, Feb. 25th.

ROYAL SOCIETY OF ARTS.

4.30 p.m. At John-street, Adelphi, London, W.C. 2. Cantor Lecture on "The Economic Condition of the United Kingdom before the War, the Real Cost of the War, and Economic Reconstruction," by Mr. E. Crammond. (Lecture II.)

TUESDAY, Feb. 26th.

ROYAL INSTITUTION.

3 p.m. At Albemarle-street, Piccadilly, London, W. 1. Lecture on "The National Physical Laboratory." Lecture I. "A National Laboratory of Industrial Research," by Sir Richard T. Glazebrook, F.R.S.

ILLUMINATING ENGINEERING SOCIETY.

5 p.m. Royal Society of Arts, John-street, Adelphi, London, W.C.2. Paper on "A Survey of Methods of Directing and Concentrating Light," by Lieut.-Commander H. T. Harrison, R.N.V.R.

INSTITUTION OF ELECTRICAL ENGINEERS, MANCHESTER LOCAL SECTION.

7 p.m. At the Engineers' Club, 17, Albert-square, Manchester. Paper on "Large Batteries for Power Purposes," by Mr. E. C. McKinnon.

WEDNESDAY, Feb. 27th.

ROYAL SOCIETY OF ARTS.

4.30 p.m. At John-street, Adelphi, London, W.C. 2. Paper on "Organisation of Commercial Intelligence," by Sir William H. Clarke, K.C.S.I.

THURSDAY, Feb. 28th.

INSTITUTION OF ELECTRICAL ENGINEERS.

5.30 p.m. At the Institution of Civil Engineers, Great George-street, Westminster, London, S.W. Private and informal meeting for the purpose of discussing the provisions of the Patents and Designs Bill.

INSTITUTION OF ELECTRICAL ENGINEERS, STUDENTS' SECTION.

7 p.m. At Northampton Polytechnic Institute, St. John's-road, London, E.C. Paper on "The Testing of [illegible]," by Mr. R. [illegible].

FRIDAY, March 1st.

ROYAL INSTITUTION.

5.30 p.m. At Albemarle-street, Piccadilly, London, W. 1. Discourse on "The Modern Dye-Stuff Industry," by Prof. A. G. Green, F.R.S.

The New Split-Phase Locomotive of the Pennsylvania Railroad: Mechanical Equipment.*

By G. M. EATON.

The huge electric locomotive which has recently been built by the Pennsylvania Railroad marks an additional step in a scheme of standardisation of electrical equipment which will be suitable for operation on their whole system. In general this locomotive, which is much more powerful than any other locomotive ever built, is similar to those in use by the Norfolk & Western Railroad on their Elkhorn Grade electrification, in that its power is supplied by three-phase induction motors, fed through a transformer and a phase converter from an 11,000 volt, single-phase contact wire. Many of the important details are, however, distinct departures from previous designs.

SERVICE CAPACITY.

In designing a locomotive for general service it was naturally laid out to give satisfactory operation over the heaviest grades on the system. These occur between Altoona and Johnstown, Pa., and include 24 miles of 1 per cent. grade west of the summit at Gallitzin and 12 miles of 2 per cent. grade on the eastern slope. It is estimated

FIG. 1.—VIEW OF NEW ELECTRIC FREIGHT LOCOMOTIVE OF THE PENNSYLVANIA RAILROAD.

that two of these engines, one pushing and one pulling, will, when the division is electrified, be able to haul a 3,900 ton train up the 12 mile grade of 2 per cent., or a 6,300 ton train up the 25 mile 1 per cent. grade, at 20·6 miles per hour. The continuous capacity of each locomotive at a speed of 20·85 miles per hour, enables a trailing load of 2,300 tons to be hauled up a 1 per cent. grade; 4,100 tons up a [illegible] grade or 11,000 tons on level tangent track.

While the nominal one-hour rating is 4,800 H.P., or approximately 87,000 lb. tractive effort at a speed of 20·8 miles per hour, the locomotive is capable of exerting a starting tractive effort of 130,000 lb. or equivalent to 7,000 H.P. For starting and "slow order" [illegible] connections of the motors are provided. When [illegible] of continuous capacity, the locomotive is capable of [illegible] 4,000 H.P. at 21 miles per hour. The speed [illegible] is considered to be about the maximum desirable for the operation [illegible], being governed by the size of trains, as well as [illegible] of grade and alignment.

[illegible] of proper [illegible] in steam locomotive development [illegible] played a leading part in the determination of the design.

1. The locomotive must [illegible]

2. The component parts of the locomotive must be able to produce this maximum capacity, must be of rugged construction, and must be adapted to an economical stowing in the locomotive.
3. As much of the weight as possible must be spring-supported.
4. The centre of gravity must be high.

The mechanical parts of this locomotive were designed and built by the Pennsylvania Railroad Co. The general type was evolved during a long period of analytical study of the fundamental service requirements, the Pennsylvania Railroad and the Westinghouse Electric & Mfg. Co. working together on the problem. This resulted in the production of a harmonious unit, embodying the results of the best existing experience along both mechanical and electrical lines.

SINGLE CAB DESIGN.

This engine is a radical departure from the common design of large electric locomotives, having a single cab, with an overall length of only 76·5 ft., a total weight of 250 tons, thereby securing a remarkably high-weight efficiency with great horse-power. The cab is mounted on two pivoted trucks which are articulated together in a unique manner. The cab weight is divided between the truck centre plates and spring-cushioned friction plates which work in series with the main semi-elliptic springs. The spring-cushioned friction plates are located midway between the second and the third driving axles. The cushioning springs are so located and proportioned that the desired weight distribution at the rail is secured.

Each truck has three pairs of 72 in., rod-connected driving wheels grouped on a 13 ft. 4 in. rigid wheel base. Outside the rigid wheel base is the jackshaft, carrying on each end a gear centre, rod-connected to the adjacent driving wheel. The main body of the jackshaft is $11\frac{1}{8}$ in. in diameter, with a long taper on each end to receive the gear centre. An axial hole, 3 in. in diameter, pierces the jackshaft from end to end. The jackshaft is driven by two motors, each of which has a pinion mounted on each end of the armature shaft. The active iron of the stators of the two motors is mounted in a unit motor frame and locomotive cross-tie casting; this casting also entirely surrounds the jackshaft.

The armature bearing housing-fit in the side frame departs from a rectangular shape in that the sides are slightly tapered. The housing is forced into the corresponding jaw in the side frame, under pressure sufficient to produce local stresses in excess of anything that will be imposed in service, and it is bolted in place, both horizontally and vertically. The bearings determining the gear centre distance are, therefore, located as securely as if they were in a single integral casting. Some of the details appear in Fig. 2.

BEARINGS AND GEAR.

The jackshaft bearing brass consists of a solid bronze bushing, pressed into an eye in the side frame. The renewal of this brass involves the removal of main gear from the jackshaft. The ruling idea in this design is that a bearing which will run a maximum mileage between overhaulings, and then involves a back-shop operation, is preferable to a more easily handled but shorter lived bearing.

The armature bearing is arranged with oil ring lubrication. The jackshaft is fitted with oil and waste lubrication, there being a large waste cavity in the side frame casting, and located directly over the journal.

The flexible gear is the type developed by the Westinghouse Co. for railroad service. While it has been quite widely applied previously, this is the first commercial application in connection with rod drive, and no other railroad application approaches it in the amount of power transmitted. The gear face is 10 in. wide. This is a radical departure from previous railroad practice with overhung gearing, made practicable by dividing the gear rim at its mid-width into two rings, and providing independent flexibility for each ring

* [illegible] The [illegible] Journal, [illegible]

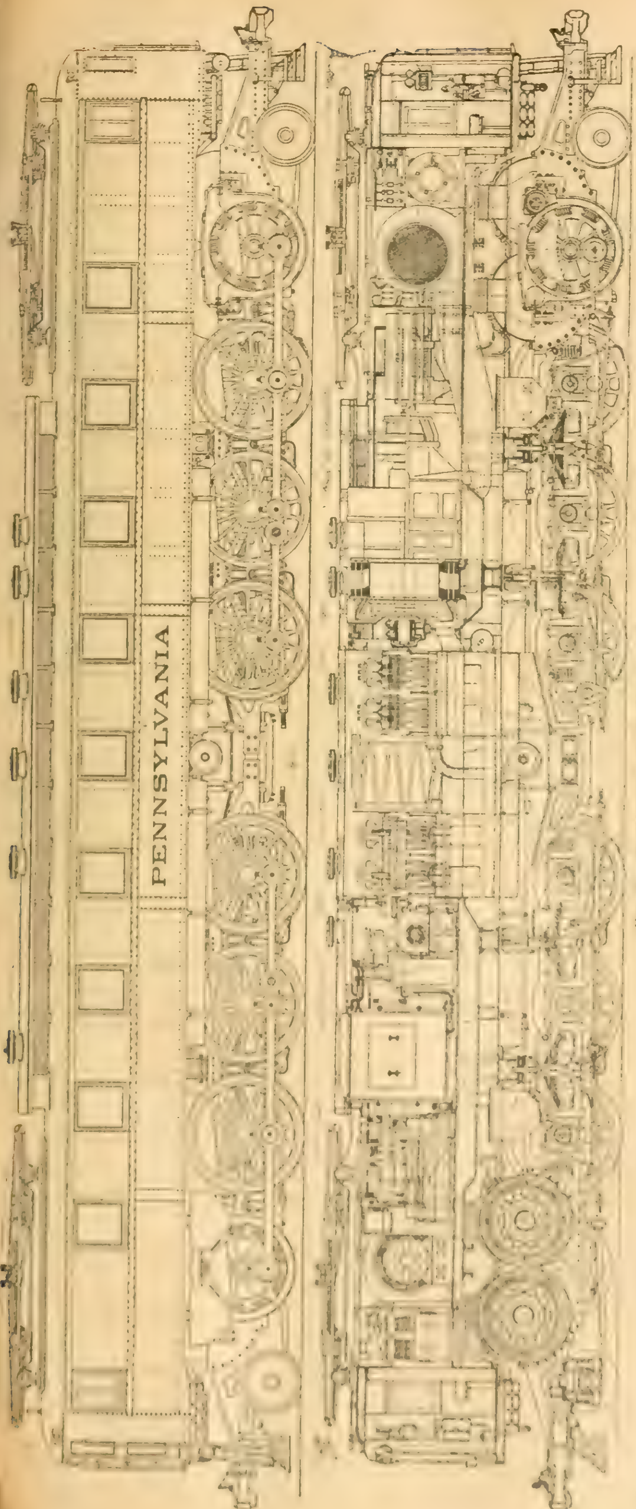


Fig. 1.—Elevation and Section of Locomotive.

relative to the gear centre. An integral pinion meshes with both rims, the independent flexibility ensuring approximate division of maximum loads. The teeth have 1¾ diametral pitch, and are 10 deg. helical, right and left, producing the effect of a herring-bone gear with the recess between the slopes of the V.

TRUCKS.

Each truck has three-point equalisation. The three drive wheels on each side are equalised together, the leading idle axle forming the third point. On top of each main journal box rests a pair of [illegible] bars, link connected to semi-elliptic springs which are located in windows in the side frames. This system terminates at each end of the rigid wheel base in a link connected helical spring, giving additional flexibility.

The bumper girder on the inner end of each truck is a portion of a circular ring with the truck centre plate as its axis, and with a rectangular cross-section. The bumper girders of the two trucks are in contact with each other. These abutting bumper girders are surrounded by a massive yoke which extends down from, and forms a rigid part of, the cab structure. Proper clearances are provided to permit relative movement of cab and trucks, except relative longitudinal displacement. The rubbing

Fig. [illegible].—Section of Motor Magnet.

surfaces are faced with manganese steel liners. This forms a very able arrangement [illegible] the bumping stresses [illegible] with ample margin of safety.

CAB.

The cab is [illegible] Westinghouse Co. [illegible] electric locomotives. [illegible] the length of the cab.

[illegible]

[illegible]

[illegible]

type, with wound secondaries. The stator (shown in Fig. 3) is bolted in place in a semi-cylindrical motor frame, which also forms the locomotive cross-tie casting, a construction which affords a considerable saving in weight, and allows easy access for overhauling. The collector rings are fitted on the shaft outside the pinion, being connected to the windings by cables through the hollow shaft. This arrangement provides maximum space for the motor core, and the brushes are readily accessible for inspection and repairs. The motors are designed for a liberal quantity of cooling air, with longitudinal ventilation. Both the stator and rotor windings are insulated with mica tape for high temperature service.

In planning the location of the apparatus in the cab to secure a compact arrangement as well as the greatest possible convenience for inspection and repairs, the following points were considered:—

1. Even distribution of weight about both the longitudinal and transverse centre line of the cab.

2. Grouping of apparatus in a compact manner so that the locomotive would have a minimum length.

3. The location of the heavier pieces near the centre of gravity of the cab so as to reduce the dumb-bell effect, both in nosing and in rolling.

4. The provision of space for air conduit to supply adequate air for the transformer, phase converter, and main motors.

5. The provision of space for convenient removal of any piece of apparatus without requiring other equipment to be moved.

6. The provision of space for convenient and adequate inspection of all equipment.

7. The grouping of apparatus so as to require the minimum length of wiring between apparatus.

8. The location of all high-voltage main circuit and rotating apparatus in a central compartment, and all equipment necessary for the control of the locomotive in the operator's compartment at each end.

9. The provision of an unobstructed passage-way down both sides of the locomotive, thus permitting easy passage from one end to the other, and access to both sides of all apparatus.

10. The location of the pantagraphs so as to provide necessary space for the installation of the 11,000 volt trolleys, and to keep within the clearance limitations, and at the same time to locate the pantagraph approximately over the truck centre pin so that side displacement of the pantagraph on curves will be a minimum.

11. The combination of all the liquid rheostats within a single tank so that the electrolyte in all the rheostats will have the same density and temperature.

Table I. *Principal Characteristics of the Locomotive.*

[illegible] classification	FF1
Overall length	76 ft. 6¼ in.
Total wheelbase	63 ft. 11 in.
Driving wheelbase	38 ft. 8 in.
Rigid wheelbase	13 ft. 4 in.
Height from rail to locked position of pantograph	15 ft. 6 in.
Height from rail to top of cab	14 ft. 8 in.
Width over cab body	10 ft. 0 in.
Overall width	10 ft. 1 in.
Diameter of driving wheel	72 in.
Diameter of pony wheel	36 in.
[illegible]	198 tons
Number of driving axles	6
Weight on each pony truck	21 tons
[illegible]	250 tons
[illegible]	11,000
Tractive effort at one-hour rating of motors	87,200 lb.
Starting tractive effort	130,000 lb.
Speed	20·6 m.p.h.
Capacity of locomotive, one-hour rating	1,800 H.P.

Electric Furnace Progress in U.S.A.

At the recent [illegible] Convention of the American Foundrymen's [illegible] devoted to Papers on recent aspects [illegible]

[illegible] Paper on "Recent Developments in the Application of the Electric Furnace to the Melting Problem," [illegible] pointed out that [illegible] in operation in [illegible] ferro-alloys [illegible] furnace in the [illegible] production [illegible] the electric furnace [illegible] phosphorus and meeting [illegible] United States [illegible] furnace for [illegible] sulphur [illegible] the melting of malleable [illegible] industry. At [illegible] with the cupola for melting grey iron. It was useful, however, in manufacturing aeroplane motor cylinders of very high-grade grey iron, owing to the facts that the sulphur content was kept down, that the metal was melted under conditions ideal for the production of iron free from air-holes, and that the iron produced from an electric furnace had the same density that was characteristic of electric steel. The use of the electric furnace for melting ferro-manganese was gaining ground, especially in large steel plants operating a number of open-hearth furnaces. In a representative case the loss of manganese was less than 10 per cent.

Results of operation in the plants of the Sivyer Steel Casting Co. (Milwaukee, Wis.) and the Electric Steel Co. (Chicago) were given in a Paper by C. R. Messinger on "Comparison of the Electric Furnace and Steel Converter for Manufacture of Small Steel Castings." The author discussed the operation of two bottom-electrode single-phase electric furnaces. The best results were obtained with acid linings. An average of 368 heats per lining has been obtained, with a refractory cost of 7·8 cents per ton of steel. The electrode cost was 70 cents per ton and the power consumption average 635 kw.-hours per ton. The total costs showed a slight margin in favour of the electric furnace, but in the East, where the freight on low-phosphorus pig iron was much lower, the margin would be in favour of the converter. In the best 30-day period an average of 9·24 heats per 24 hours was obtained, the average melting time being 2 hours and 25 minutes and the average charging time 10 minutes. The furnaces were of 1-ton capacity. The average labour cost was $2.10 per ton of steel melted, including bringing scrap in from the yard and repairs. The consumption of electrodes on a furnace making 2,029 heats in thirteen months was 13,170 lb., or 5.15 lb. per ton of steel melted. The present cost of graphite electrodes was about 13 cents per pound. The foregoing furnace was used in pouring very small castings with an average weight of less than 4 lb.; hence the furnace was not tapped until the metal was very hot and the power was left on longer than would be required in most foundries. A power consumption of 570 kw.-hour per ton could easily be attained by greater care in operation. Repairs need not be made oftener than once in six weeks. Numerous classes of scrap could be utilised. Continuous service by the central station was most important. A plant with a power rate of 0·75 cent per kilowatt-hour would save $8 per ton in the cost of finished castings over a plant with a 1·5 cent rate, other things being equal.

The Central Station Point of View.

"The Electric Furnace from the Central Station Viewpoint" was the title of a Paper by Edwin L. Crosby, of the Detroit Edison Co. So far about 200 electric furnaces, having an annual capacity of 1,200,000 tons of steel, had been installed or contracted for in North America. That steel production required about 750,000,000 kw.-hours. Errors in installation and application should be avoided through a closer study o electric furnace equipment and service than had been made in the past. The power salesman should have a fairly good understanding of the metallurgical practice involved before attempting to give advice or data. With the possible exception of one type of arc furnace and the certain exception of the induction furnace, all steel furnaces on the market, if properly installed, would operate with a power factor of 80 to 85 per cent. during the early stage of the melting period, later rising to 85 or 90 per cent., and finally to 95 per cent. or better during the refining period. Regulation, phase balance and wave distortion had not received sufficient attention. Present electrode regulation was at best very unsatisfactory, it being impossible with any existing equipment to obtain sensitive regulation without hunting of electrodes and disturbance of phase balance. Wave distortion common to arc furnaces might lower the efficiency of rotary converters and affect the accuracy of watt-hour meters. Any central station man who urged the installation of electric furnaces for steel based upon the present market might later have cause for regret, unless he receives a rate commensurate with the risk.

Mr. John A. Crowley, in a Paper entitled "Notes on an Electric Furnace Design," described a 1-ton electric furnace built by the author. In choosing between a rugged, simple design and one more finished and complex, the author recommended the former, which would require little or no attention, and replacements could be made more rapidly in case of breakdown. A 1-ton furnace of any design would range in price from $15,000 to $25,000. Most successful polyphase furnaces were equipped with automatic electrode control. In the case described, totally enclosed motors were employed to effect the electrode movements. Below are given conversion cost data on a 1-ton furnace. The power and electrode consumption figures were obtained from furnaces of similar size operating in Europe. The price of scrap is based on Pittsburg prices current about September 1st and the labour costs are based on conditions existing in Detroit about September 1st. An average rate for power the country over is $0.01 per kilowatt-hour. The figures are as follows:

Scrap (turnings)	$24.00
Power, at $0.01 per kilowatt-hour	7.00
Electrodes, at $0.075 per lb.	1.35
Slag material, lime, spar and coke	0.30
Alloys (approximate)	
4 lb. 50 per cent. ferro-silicon	0.48
3 lb. 80 per cent. ferro-manganese	0.59
1 lb. aluminium	0.65
Refractories (basic)	0.45
Skilled labour, melter $6, boy, $3.50	2.38
Unskilled labour, two men 40 minutes each heat to handle scrap and charge furnace, at $0.32 per hour	0.32
Cost of metal at the spout	$37.52

The above costs are based on 24 hour operation with a minimum production of 8 tons per day.

Notes on the Design of Electromagnetic Machines.*

PART III.

DESIGN OF AN ALTERNATING-CURRENT TURBO-GENERATOR.

By STANLEY PARKER SMITH, D.Sc.

(Continued from page 686.)

Summary.—In Part I. of the article the author deals with some of the main principles underlying the design of alternating-current generators. In Part II. these principles are applied to the design of a low-speed, three-phase alternator, giving 750 kw. at 2,200 volts when running at a speed of 250 revs. per min. In Part III. a three-phase turbo-alternator is designed to give 2,000 kw. at 3,000 revs. per min. at a line pressure of 500 volts, and the mechanical stresses in the rotor are discussed.

(e) *Effect of the Cores.*—In 2-pole machines, the reluctance of the rotor core may be pretty considerable, but it is found to have roughly the same trapezoidal distribution as the rotor ampere-turns, so that it will not have much influence on the distribution of the flux. In four- and six-pole machines, the reluctance of the rotor is mostly small, and likewise the stator reluctance is seldom large in any 50-cycle machine. Consequently we are justified in assuming in general that the reluctance of the cores has no effect on the flux distribution in the gap, and merely add to the total excitation required for the magnetic circuit.

(i.) *Stator Core.*—The ampere-turns for the stator core of 50-cycle turbo-alternators can be calculated in the same way as for slow-speed machines, by assuming the flux density along the stator path to be uniform and equal to the mean density at the cross-section of the core midway between two poles. The mean length of the path is readily obtained from a drawing or sketch, as in Fig. 24, or can be estimated as two-thirds of the pole-pitch at the middle of the core.

The depth of the core is

$$h=(150-65)/2-8=34{\cdot}5 \text{ cm.}$$

The axial ventilating ducts, however, reduce the available depth considerably, and in the present design we estimate that the depth will be reduced on the average by an amount equal to the diameter of two holes. Since the diameter of the holes is 4·5 cm., the effective core-depth will be

$$h'=34{\cdot}5-2\times 4{\cdot}5=25{\cdot}5 \text{ cm.}$$

With the axial length of iron $L_i=87$ cm., the active cross-section of the core will be

$$A_c=h'L_i=25{\cdot}5\times 87=2\,220 \text{ cm.}^2$$

The calculation of the ampere-turns for the core with the values of flux just obtained are entered in column 5 of Table V.

(ii.) *Rotor Core.*—At the higher points on the O.C.C. of a two-pole machine, the rotor core may consume about half the total excitation, and must therefore be estimated with greater care. In a two-pole rotor, the lines of induction are distributed nearly uniformly over any transverse section of the core.

From the cross-section drawn in Fig. 24 the transverse width b_x of the core at the bottom of each slot can be measured off. These dimensions are entered in the column for b_x in Table VI.

Near the bottom of the ducts, the axial length of the cross-section is obviously equal to the gross core length of 100 cm., but at the diametral section the flux spreads out considerably into the rotor shaft. To allow for this we assume that the fringing at each end is equal to about one-eighth of the dotted circle, so that the axial length L_x at the diameter will be $100+2\times 35/8=108$ cm. At intermediate sections equal steps of 2 cm. can be taken as shown in the third column of Table VI. The area $b_x L_x$ of the magnetic path through the rotor at each section can then be found and is entered in the next column in the table.

The flux crossing each section is equal to the useful flux plus the leakage flux. Thus we must not read off the actual gap densities from curves (1) and (2), but from curves (3) and (4), for which the magnetisation of the teeth and pole-centre were calculated. The values of B_g thus read off for each of the four excitations chosen are entered in their respective columns in Table VI., but are only shown here for the case of AT for teeth and gap = 20,000.

Table VI.—*Calculation of Ampere-turns for Rotor Core.*

AT for teeth & gap =				20,000				
No. of slot x	Width at x b_x	Length at x L_x	Area at x $b_x L_x$	B_g.	$\Delta\Phi$ 10^{-6}	Φ 10^{-6}	B_r.	at.
1	15·4	100	1,540	9,700	30·1	30·1	19,600	340
2	21·6	102	2,200	7,200	11·2	41·3	18,800	210
3	26·6	104	2,770	6,400	9·9	51·2	18,500	180
4	30·8	106	3,260	5,000	7·8	59·0	18,100	140
5	32·8	108	3,540	2,900	4·5	63·5	18,000	130
							at_{mean}	186
					$AT = 16{\cdot}5$		$at_{mean} =$	3,070

The flux passing through each section of the core can now be found. For the pole-centre, the first value of B_g must be multiplied by the gap area over this part, namely, $4A_g/26=3{,}100$ cm.². The flux entering by each pair of teeth, one on either side of

Fig. 24.—[illegible]

the lines, is similarly found by multiplying all the remaining values of B_g by the area of the gap over two slot-pitches, namely, $2A_g/26=1{,}550$ cm.². These are entered in the column under the heading $\Delta\Phi$ and the total flux Φ at any section is then obtained by adding together the values of $\Delta\Phi$ down to that section.

It only remains to find the density B_r at each section by dividing the flux by its corresponding section, and reading off the ampere-turns from the iron curves in Fig. 19. To find the mean value at_{mean} we can proceed graphically, as for the stator teeth, whence we find the required AT and enter the value in column 6 of Table V.

(f) *The Open-circuit Characteristic.*—By adding together the ampere-turns in columns 4, 5 and 6 in Table V., the total ampere-turns per pole on no-load are obtained, so that the magnetisation curve of the machine can be plotted straight-

* The first article of this series dealt with Continuous-current Machines, and the first part of the article appeared in THE ELECTRICIAN of June 2, 1916 (Vol. LXXVII., p. 280).

way. This is shown in Fig. 25, where the phase pressure is drawn as a function of the ampere-turns per pole-pair. The figures for the air-line are shown in brackets in Table V—this line is useful when drawing the open-circuit characteristic (O.C.C.).

In this way, then, the magnetisation curve has been calculated for a 10/13ths winding on the rotor ($\beta=10/13$); and in a precisely similar manner, the curves in Fig. 23 have been redrawn for an 8/13ths winding. In the latter case, the dimensions of the wound and unwound slots are the same as in the former; but with $\beta=8/13$ there are 8 wound and 5 unwound slots per pole, whilst with $\beta=10/13$, there are 10 wound and 3 unwound slots per pole. The predicted O.C.C. for $\beta=8/13$ is also shown in Fig. 25.

(*g*) *Short-circuit Characteristic.*—The excitation needed to send a current through the stator winding when short-circuited is due to the inductance and reaction of the stator winding.

In section 2 of this part, it was shown that the inductive drop in the stator winding is equal to 13·8—or, say, 14 per cent. of the normal pressure. Setting this off along the vertical co-ordinate in Fig. 25, the ampere-turns needed to provide the flux for producing the E.M.F. to overcome the reactive pressure E_s+E_0 are found at once.

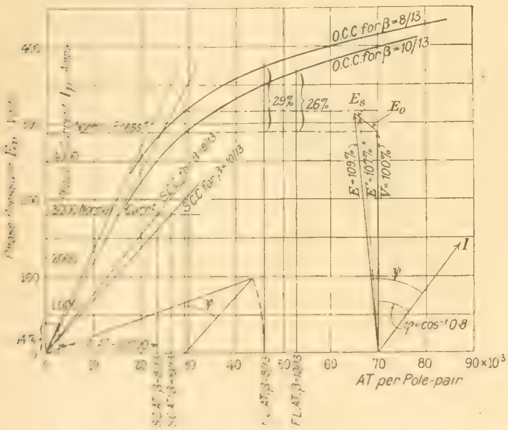


Fig. 25.—Open- and Short-circuit Characteristics for $\beta=10/13$ and $\beta=8/13$.

Excitation and Regulation shown for full load at $\cos\varphi=0·8$.

For the armature reaction, we have from equation (7) in Part I

[illegible]

Hence [illegible]

By adding these ampere-turns to the respective ampere-turns needed for the inductive drop, we then find the total ampere-turns needed to send full-load current through the short-circuited stator winding, and so get the short-circuit characteristics shown in Fig. 25 by setting off the current to a suitable scale.

(*h*) *Excitation on Full Load.*—In this case, we use the vector diagram based on Fig. 2 [illegible] with more justification than for salient-pole machines, because the distribution of the rotor M.M.F. approaches a sine curve, and this, combined with the sinusoidal stator M.M.F., gives a resultant not differing widely from a sine wave. Since the pole-centre is usually slotted differently from the wound part, the reluctance of the magnetic path will not be uniform over the rotor periphery, so that the flux curve on load will be somewhat distorted, but this is seldom observable in the phase and terminal pressure waves.

Though the rotor leakage is increased on load by the ampere-turns needed to counteract armature reaction, the effect is usually small and will be ignored here. We shall therefore use the convenient construction for the E.M.F. and M.M.F. vectors shown in Fig. 25, which is mostly accurate enough for turbo-alternators with cylindrical rotors.

The construction is only shown for full load at $\cos\varphi=0·8$ when $\beta=8/13$, but the diagram for unity power factor is drawn in the same way. With the current corresponding to $\cos\varphi=0·8$, the inductive pressure $E_s+E_0=14$ per cent. of the normal pressure, whence we find $E=109$ and $E'=107$ per cent. of the normal pressure. Consequently the gap flux on load must be increased 9 per cent., corresponding to $E_p=315$ volts; whilst the core flux is increased 7 per cent.

To the ampere-turns required for $E_p=315$, we now add the ampere-turns required to overcome armature reaction, namely, 22,800 for $\beta=10/13$, and 20,700 for $\beta=8/13$, the internal phase angle ψ being read off the pressure diagram. In this way we find

Exciting ampere-turns on full load at $\cos\varphi=0·8$

$=53{,}000$ when $\beta=10/13$.

$=46{,}000$ when $\beta=8/13$.

In section 4, we shall see that the latter alternative is better.

(*i*) *Iron Loss.*—To reduce the iron loss as much as possible, not only must the core be carefully built, but it is advisable to use thin laminations—*e.g.*, No. 29 S.W.G.$=$0·35 mm.

Core Loss.—It will be remembered that there are 144 axial holes through the core, each 4·5 cm. diameter. The flux passing through the core on full load is

$$1·07\times 45·5\times 10^6=48·7\times 10^6.$$

For the core, we have, then:—

Area of plate	$=\pi 31·5\times 115·5-144\frac{\pi}{4}4·5^2=10{,}200$ cm.²
Volume of core	$=10{,}200\times 87=888{,}000$ cm³.
Weight of core	$=7·8\times 888{,}000\times 10^{-3}=6{,}900$ kg.
Flux-density in core	$=\dfrac{(48·7\times 10^6)}{(2\times 2{,}220)}=11{,}000$ lines per cm².

Hence, using the formula as given in the previous article:—

Loss per kg. $=2·5fB^{1·6}10^{-8}+0·01B^2t^2f^2 10^{-8}$ watts

$=2·5\times 50\times 11{,}000^{1·6}\times 10^{-8}+0·01\times 11{,}000^2\times 0·35^2\times 50^2\times 10^{-8}$

$=3·7+3·7=7·4$ watts,

whence the iron loss in the core $=6{,}900\times 7·4=51$ kw.

Tooth Loss.—From Fig. 23c, we find that for a flux wave corresponding to $\Phi=48·7\times 10^6$, the ratio $B_{max.}/B_{mean}=1·6$. in the teeth under the pole centre. We shall calculate the loss for the density existing one third of the way down the tooth, measured from the circumference. Then we have

Volume of teeth	$=36\times 8\dfrac{3·47+4·87}{2}\times 87=105{,}000$ cm³.
Weight of teeth	$=7·8\times 105{,}000\times 10^{-3}=820$ kg.
B_{mean} at one third tooth depth	$=\dfrac{48·7\times 10^6}{18\times 87\times 3·9}=8{,}000.$
$B_{max.}$ at one third tooth depth	$=1·6\times 8{,}000=12{,}800.$

Hence loss per kg.

$=2·5\times 50\times 12{,}800^{1·6}\times 10^{-8}+0·01\times 12{,}800^2\times 0·35^2\times 50^2\times 10^{-8}$,

$=4·75+5·0=9·75$ watts,

whence the iron loss in the teeth $=820\times 9·75=8$ kw.

The *total iron loss* in the machine is then $51+8=59$ kw.

(*j*) *Regulation.*—The voltage rise from full load at any given power factor to no load can be read off straightaway from Fig. 25 as soon as the excitation has been determined. We then have

Voltage Rise from Full Load to No Load.

	$\cos\varphi=1·0$.	$\cos\varphi=0·8$.
$\beta=10/13$	10·5 per cent.	26 per cent.
$\beta=8/13$	13·0 „	29 „

4. The Rotor Winding.

Having thus settled the exciting ampere-turns needed on full-load, we can now design the rotor winding and therefrom decide whether it is better to make $\beta=10/13$ or $8/13$.

A suitable value for the exciter pressure is 100 volts. Roughing out the cross-section of the copper in the usual way —see design of field winding in Part II.—we find this should be about 55 mm.². Experience shows the best arrangement for this class of winding is to wind flat strips one above the other. The slot is 28 mm. wide, and allowing 1·5 mm. on either side for insulation (mica between leatheroid), the width of the copper strip will be 25 mm. This gives a thickness of $55/25=2{\cdot}2$ mm. Thus the strip will be $25\times2{\cdot}2$ mm.

The older way of insulating the strips was to tape every or alternate layers, but present-day practice favours the use of bare copper with a strip of mica insulation between successive layers, which is non-combustible and takes up less room than tape.

The distance between the bottom of the wedge and the top of the duct is 90 mm., and with the insulation and slack given below it is possible to accommodate 32 conductors per slot:—

Brass liner at top of slot		1·0 mm.
Brass liner at bottom of slot		1·0 „
Slot insulation	$3\times1{\cdot}5$ =	4·5 „
Copper	$32\times2{\cdot}2$ =	70·4 „
Insulation between layers	$31\times0{\cdot}25$ =	7·8 „
Slack		5·3 „
Total depth		90·0 mm.

With this arrangement, we now find the loss and amount of copper required for the two cases considered as follows:—

Spread of rotor winding β	10/13	8/13
Cross section of conductor ...	55·0 mm.²	55·0 mm.²
Conductors per slot	32·0	32·0
Turns per pole pair	320·0	256·0
Mean length of turn	3·74·0 cm.	[illegible]
Total length of winding	1,200·0 m.	920·0 m.
Weight of rotor winding	590·0 kg.	450·0 kg.
Resistance of winding at 15° C.	0·38 ohm.	0·29 ohm.
Resistance of winding at 60° C.	0·49 ohm.	0·38 ohm.
Exciting ampere-turns on full load	53,000·0	46,000·0
Exciting current at full load	165·0 amps.	180·0 amps.
Slip ring pressure at full load	81·0 volts	68·5 volts
Rotor copper loss at full load	13,400·0 watts	12,300·0 watts
Current density at full load	3·0 amp./mm.²	3·3 amp./mm.²

Comparing the above alternatives, it is seen that the slotting for $\beta=8/13$ needs less copper, entails less loss, requires less labour, provides better ventilation.

Thus it is better in every way to have $\beta=8/13$, and the alternative of 10/13 will not be considered further. In passing, it may be mentioned that, generally speaking, it is better to make $\beta=2/3$ rather than 3/4 or 1/5.

(To be continued.)

Linking-up of Dublin and District.

INTERIM REPORT OF THE COMMITTEE.*

The Committee, in presenting this report, wish to make it clear that it is only of a preliminary nature, and deals with certain inter-connection of existing stations which can immediately be made at a small capital outlay, and would effect a saving of fuel, which is very important in Dublin, and will relieve the pressure in happening. [illegible]

The total output of public and private power plant in the district at present exceeds 20,000 kw., and it is expected to exceed 30,000 kw. within a comparatively short period. The public supply of electricity for the City of Dublin and the district [illegible] is derived from no less than [illegible] generating stations. All the stations, with the exception of the Pigeon House Station of the Dublin Corporation and the Dublin United Tramways Co.'s station, are small; and, with the exception of the Port and Docks Board's station and the two large stations referred to, are disadvantageously situated, both in regard to condensing facilities and coal supply.

The cost of generation at the Dublin & Lucan Co.'s station is 3·34d. per unit, the coal consumption being over 13 lb. per unit; and a more unfavourable condition of things must obtain at the Sutton power house of the Great Northern Railway Co. The proprietors of both these undertakings are desirous of obtaining an immediate supply in bulk. The cost of cables, rotary converters, &c., for Lucan station would not exceed £8,000, and would result in an annual saving of 1,004 tons of coal per annum. The cost of providing a supply to the Sutton station is estimated at £13,500, and the saving in coal at 1,317 tons. The power house maintained by the Dublin Port and Docks Board for the supply of power for the cranes on the quay, and motive power for their own yards and workshops and for lighting, is conveniently placed for obtaining coal and condensing water. But it is small, and it could profitably take a bulk supply.

An immediate linking-up could be made between the Port and Docks Board's station and either the Pigeon House station or the tramway company's station. There is a very considerable and growing demand for power in the vicinity of the Port and Docks Board's power house, where the industry of building and repairing ships has been growing steadily for some years past. A three-phase supply could be obtained either from the Pigeon House station or the tramways company's station, as might be found suitable.

The Pembroke and Rathmines generating stations may be regarded as moderately economical, and both are combined with refuse destructors which provide part of the steam for the engines. The feeders of the two systems approach one another at one point, and the committee advocate an immediate inter-linkage between the two at this place. This would permit of the shutting down of the Rathmines station throughout the whole of the summer months, as far as coal-fired boilers are concerned, and would thus save a very considerable quantity of coal. The destruction of refuse would still be carried on at Rathmines during the summer, and would provide part of the supply. It is suggested that this inter-linkage could be carried out at a very moderate expense, and would yield an immediate and valuable economy. The cost is estimated at [illegible]

The Committee consider that it would be very desirable to have an inter-linkage between either the Pigeon House station or the Ringsend station of the Dublin United Tramways Co. and the Pembroke Urban District Council's power station; the high-tension mains of both these stations pass within a couple of hundred yards of the Pembroke station.

[illegible] south-westerly direction to Poulaphouca, serving that district as well as [illegible] the roadside throughout. The locomotives are self-contained, only two of which are of a modern petrol-electric type, with provision for trolley wire running when available; the balance of the locomotives are steam-driven. This system also intersects the system of the Dublin United Tramways Co. There is already through-running between the two [illegible] traffic, and the committee are of opinion that, in the interests of both systems and the city, such an arrangement would be advisable, as opening up a district well suited for both the better-class buildings and for [illegible]

The Committee is of opinion that a commencement should be made with a view to the development of this line by extending the electric system of the D.U.T. Co. a distance of 6½ miles with through-running passenger cars to the centre of the city; later this arrangement to be extended over the whole line. The committee has not made an estimate of the cost of the extension proposed, but it is satisfied the conditions considered upon commercial lines are favourable in view of the fact that the D.U.T. Co. have conduits available through the city in which cables could be laid without opening the streets between the power station and the Blessington system at Terenure, while for the remainder of the distance over the Blessington system the cables could be carried on the tramway poles necessary for the trolley wire. In this way [illegible] could be extended as required, and advantage taken of electric power available at Ringsend generating station [illegible]

The Committee have ascertained [illegible] the amount of electric power which would probably be required [illegible] in and about Dublin if power could be offered at a low figure. The present and projected demands for power in the area [illegible] amount to 30,000 kw.

[illegible]

[illegible]

* The Committee consisted of [illegible]

Switchgear Standardisation.*

By C. C. GARRARD.

Summary.—The author considers the various parts of switchgear which can, in the present state of the art, be standardised with advantage.

Switchgear standardisation has already had considerable attention paid to it in America, Switzerland, and Germany. One object in view in submitting this Paper is to call attention to this fact and to urge that such steps be taken as will put an end to this unsatisfactory state of affairs.

The authority for engineering standardisation in this country is the Engineering Standards Committee. According to the 1917 report of the Committee no single standard specification dealing with any form of switchgear has been issued. Specifications dealing with wall plugs and ceiling roses have, it is true, been prepared, but these come under the domain of accessories and not that of switchgear properly understood. In fact, there does not seem to be any suitable organisation within the Standards Committee to deal with such work. There is a sub-committee, with a number of panels, for dealing with electrical accessories. But heavy modern switchgear is not properly classed under this designation. It would appear that there is urgent need for the formation of a special sub-committee to deal specifically with switch and controlling gear. This sub-committee could arrange for its special panels for the various subjects, and there need be very little, if any, overlapping of the existing electrical accessories sub-committee and panels.

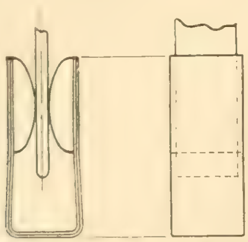


Fig. 1. Controller-finger Type of Switch Contact.

In the following résumé it is desired to explore to some extent the ground indicated, and to discuss a number of matters in connection therewith.

The author suggests the adoption of the American standard test pressures for switchgear, and gives specifications for brass and [illegible]

Knife Switches.

A standardisation of the length of break, distance between the centre lines of the poles, sizes of terminals, current density in the material, and general style of construction is very necessary. As regards the current density of surface contacts, it is not desirable to fix limits as to this, as apparently very high surface densities sometimes yield very good results. There is much to be said in favour of the type of switch contact illustrated in Fig. 1. The explanation would appear to be that with the ordinary form of flat contact the current really only passes at a single or a few points. With the controller finger type, however, a definite line contact is obtained. A standardisation of the millivolt drop, at contacts, however, would be a very good thing, and, as this is a direct measurement of the capability of the device to make contact, has much to recommend it. The values given in Fig. 2 are founded on actual practice in good class work.

Connection Studs and Nuts.

Considerable variation exists at present in the practice of different manufacturers in regard to back connection studs, more especially in regard to the screw threads adopted. In the original Paper one [illegible] thread for the purpose is suggested.

The nuts for making the connection between the studs and the [illegible] should be thinner than standard Whitworth nuts. This is necessary from considerations of space, which is naturally limited at the back of switchboards. The best arrangement is to make the [illegible] the thickness of the standard [illegible]

Oil Switches.

The standardisation of oil switches is at the moment receiving attention, and will therefore not be discussed a great length here. It will, however, not be out of place to call attention to the considerable amount of work which has taken place in other countries. This has had the result, before the war, of greatly assisting our foreign competitors' export trade in switchgear.

The most important point in the standardisation of switches is that of their rating in terms of breaking capacity. It is obvious that such a rating can only be reliable if based upon actual experience. It must be confessed that many of the ratings of oil switches which are guaranteed by various manufacturers are merely "intelligent guesses," as means for making such tests are as a rule not available. The opportunities for making such tests in this country are, however, very few. In this connection it is noteworthy that recently, and since the war, the Allgemeine Electricitäts Gesellschaft of Berlin has built a special laboratory for the specific purpose of testing oil switches. This has been described recently in the technical Press.* It is worthy of the attention of the Institution that while last year the British Government, through the Department for Scientific and Industrial Research, encouraged an investigation in the subject of "Switching and Arcing" to the extent of a few hundred pounds, at precisely the same time this Berlin firm was building a special laboratory for exactly the same research at a cost probably one hundred times as great. The author suggests the establishment of a national high-tension research and standardising laboratory which could deal with these problems. The very best engineering talents should be secured for its direction, and considerable financial resources would have to be available for the largescale experiments necessary.

Maximum Possible Breaking Capacity of an Oil Switch.—The leading consideration to be borne in mind when installing an oil switch on a large system is the maximum power in kilovolt-amperes which it will have to rupture. On large modern plants this power becomes very large. The use of reactances to limit the short-circuit current has now become recognised as essential for continuity of supply. While it is no doubt possible to construct oil switches for any duty whatsoever, yet if too great a demand be made upon them they become so large and unwieldy that it is better to adopt other means of limiting the short-circuit current and thus enabling the relatively smaller switches to be used. It is suggested, therefore, that a maxmium breaking capacity of 500,000 k.v.a. should be regarded, at any rate with the present state of the art, as the largest short-circuit load with which any oil switch should be called upon to deal.

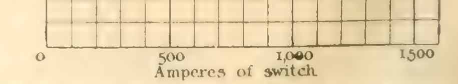


Fig. 2. Millivolt Drop at the Jaws of Knife Switches.

The standard rules when formulated should embrace sizes up to this value. It may be added that this maximum breaking capacity is considerably larger than any of the standards set up by the V.D.E., and would therefore constitute a considerable advantage over those rules.

Resistance and Reactance Type Oil Circuit-breakers.

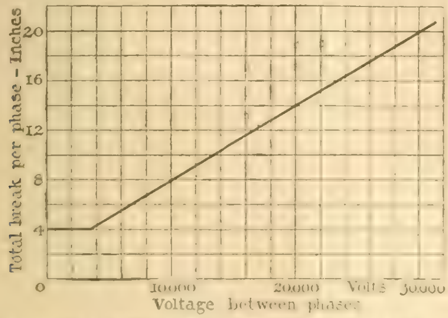
The use of the two-step oil switch having a resistance or choking coil connected between the two steps has been advocated in some quarters. The Swiss Elektrotechnischer Verein in its report (see page 13) recommends this. Such switches may be regarded from two points of view, that is to say, switching on and switching-off.

* Abstract of a Paper read before the Institution of Electrical Engineers.

* "The Electrician," 1917, Vol. LXXIX., p. 884.

The use of the charging resistance is of value in the case of switching-in of large transformers, for preventing the abnormal rush of current which sometimes occurs. Such a c rrent, however, lasts only for a very short time, and the only real trouble is due to the tripping of the overload release gear. This can be guarded against by a time lag on the transformer switch. For switching-in cables such double-contact switches are totally unnecessary. Large motors may be protected by a small choking coil.

The Swiss Electrotechnical Society base their recommendation of the use of such double-contact switches on their alleged capability of dealing with heavier short-circuits than single-contact switches. It is very much to be doubted whether this contention is right. The great objection to such switches is their complexity. It is possible, by means of special constructions, to shorten considerably the length of break necessary in an oil switch. It is better, however, to have such a length of break that a reasonable degree of safety is secured, even if the special devices mentioned are put out of action. By length of break is meant the total length. Fig. 3 represents the average of a number of first-class modern manufacturers and may be taken as typical of present-day designs.



[illegible]

There is an impression in some quarters that the sub-division of an oil-switch tank into three separate tanks, one for each phase, is an advantage from the point of view of operation under short circuit. Seeing, however, that the effect of this sub-division is to bring earthed metal between the phases and in closer proximity to the contacts, the effect is likely to be the other way about.

[illegible]

CUT-OUTS.

While the standardisation of cut-outs has been carried out to a considerable extent in other countries, with us practically nothing has been done. [illegible]

Many electric supply authorities issue their own specifications.

It has been generally agreed that the severity of a short-circuit test to which a cut-out is subjected may be measured by the value of the short-circuit current [illegible]

[illegible]

is short-circuited across a sufficiently large source of power with the short-circuit current limited to certain values.

Considerable discussion has taken place as to the influence upon the severity of the test of the amount of plant connected at the time the test is made. The whole of this discussion can be clarified if we take as criterion of the severity of test the value of the defined short-circuit current. It is suggested that 100 kilowatts would be sufficient for ordinary duty cut-outs and 500 kilowatts for heavy duty ones. It should be noted that these are the minimum values.

Time Element of Cut-outs.—In several of the foreign standards cut-out specifications periods of time are fixed within which the various cut-outs must operate. It is worth while to consider whether it would be advisable to include similar requirements in any British standards which may be issued.

The time taken to blow a fuse depends upon its size and the degree of overload. The current which gives a more or less instantaneous operation is very indeterminate.

The normal fusing current can best be ascertained by plotting a curve as in Fig. 4. It will be seen that the curve approaches a vertical asymptote, the value of which is the normal fusing current.

If a definite and fixed time element be specified it would in the first place be necessary to specify a different value of time element for each diameter of fuse wire; secondly, it would be necessary to have different values of time element for open, protected, and enclosed cut-outs, and likewise different time elements for each fuse metal.

The Institution Wiring Rule No. 98 *b* requires that fuses "must be so proportioned to the current to be carried that no conductor protected by them can be raised in temperature above that specified in Rule 4?." It would be very desirable if directions could be issued to guide the user in applying this rule. As it stands, the requirement simply begs the question. To specify the time element of a cut-out does not serve any useful purpose and it is suggested it should not be done.

RESISTANCE WIRE AND STARTERS.

For the construction of starters and regulators the copper-nickel alloys have stood the test of time and should be standardised. The [illegible] zinc. At the present moment many wire manufacturers make the [illegible]

[illegible]

[illegible]

(To be continued.)

The Electrician.

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Effect of Storage on the Properties of Coal.

There is a very general impression that the storage of coal for any considerable period leads to deterioration to a more or less serious extent, and this is one of the reasons why storage is not resorted to as much as it might be otherwise. From the point of view of equalisation of mining effort it is obviously desirable that coal should be stored in very large quantities. Thus, the statement is made that if the mines could be worked uniformly in the United States, thus distributing the work evenly throughout the year, the number of mines which could be thrown out of operation would represent an investment of £90,000,000. Further, there would be an even demand on the railways, so that for the same tonnage hauled a considerably smaller amount of rolling stock would be required, thus representing a further saving in capital investment. Of course, the present method leads to waste in one form or another, and this means that eventually the cost of coal is higher than it would be otherwise.

There is a great deal in the nature of coal that is not yet understood, notwithstanding the large amount of investigation to which it has been subjected. Thus, the difference between caking and non-caking coal, from the chemical point of view, has not been fully explained. Unfortunately, coal is such a complex body that it is not easily investigated. When we come to the question of the weathering of coal there are obviously various chemical and physical changes that may take place. These have been investigated at the engineering experiment station of the University of Illinois, and last year an interesting bulletin on the subject was published, the author being Prof. S. W. Parr, whose name is well known in this connection. The point that appeals most readily to engineers is the possible variation of calorific value due to storage. In this investigation a number of coals were stored in exposed bins, in covered bins and under water, the period of investigation in the two former being six years. From the figures that are given it is evident that the change which takes place is most rapid immediately after mining. During the first week the average loss in calorific value is as much as 1 per cent. The change then takes place more slowly. A further loss of another 2 or 3 per cent. may occur by the end of the first year, and at the end of six years the loss may amount to as much as 10 or 11 per cent.

This sounds rather a serious loss, but it is by no means certain that the effective loss is really indicated by these figures. Along with deterioration in the thermal value there appears to be absorption of oxygen. Freshly mined coal has a marked avidity for oxygen. There appears to be [illegible] which goes on for a considerable period. That being so it follows that the coal increases in weight, and any increase in weight, assuming that no other change takes place, would lead to an apparent diminution in calorific value. This view is supported by the fact that the [illegible] during the time of storage. Although the absorption of oxygen does not [illegible] with the [illegible] it nevertheless appears that the loss in heat value in stored coal is more apparent than real. Probably any deterioration in the thermal value is due to the evolution of combustible gases from freshly-mined coal, but the extent of this loss seems to be quite small.

Another phenomenon which may troublesome is the spontaneous combustion of coal. This is probably due to the absorption of oxygen, which produces heat to the extent of two to three calories per cubic centimetre of oxygen absorbed. During an exposure of five months the total heat thus produced is approximately 10 calories per kilogramme of coal, or about 0·12 per cent. of the heat value of the coal. This is not a large amount, but it is probably sufficient in its cumulative effect to stimulate other chemical changes and thus to bring about spontaneous combustion. There has been some discussion as to whether the presence of sulphur in coal is not a governing factor in this spontaneous heating. The point does not seem to have been proved. The fact remains, however, that all such effects are very dependent upon the size of the coal. If there is a lot of fine coal the surface exposed to the atmosphere is much greater, and if pyrites are present they will occur more in the fine coal than in the larger coal, and thus the conditions for spontaneous combustion are more favourable. Thus, in the storage of coal, fine slack should be avoided. Beyond this precaution, there seems no particular objection to ordinary methods of storage, and it is doubtful whether the more expensive method of storing coal under water can be justified.

Reviews.

Steam Turbines. By Jas. A. Moyer, A.M. (London: Chapman & Hall.) 3rd Edition. Pp. ix. + 468. 16s. 6d. net.

This volume is a third edition of a work originally published in 1908, and the author has taken advantage of the request for a new edition to enlarge and re-write a considerable portion of the previous treatise. Although there have been fresh designs and some original turbines put on the market since 1908, the main advance in turbine engineering has been in the increase of power per unit together with greater economy of the types then on the market, and in the better design and finish of the turbine parts. It is probably safe to say that in 1908 no turbine could show as low a figure as 10 lb. of steam per brake horse-power hour, but in the last six years there have been many big units of over 20,000 kw. installed, which can show results of 10 lb. or less, notably the 25,000 kw., Parsons installation at Chicago.

To return, however, to the volume under review; the author has been connected with the Westinghouse & General Electric Companies, and has, therefore, an intimate acquaintance with the practical side of his subject. The usual introductory chapter on heat theory is short, and yet gets there by means of diagrams, &c., which should appeal to the reader whose appreciation of thermodynamics is small. The chapter on nozzle design gives a great deal of the work done by Rateau in the early days of turbine engineering, but one misses a reference to that truly great paper by Callendar, published in the "Proceedings" of the Institute of Mechanical Engineers, and if that paper be accepted the ratio of pressure 0·58, as given on page [illegible] et seq., should be 0·545, which makes a great difference. Chapter IV., on "Steam Turbine Types and Blade Design," is the most satisfactory chapter in the volume, as it embodies so much of the author's own experience, and also [illegible] the problem of blade design [illegible] the problem of the [illegible]. Chapters on "Mechanical Losses" and "Methods of Conducting Steam Turbine Tests" lead up to the longest chapter of the book, viz. No. VII., on "Commercial Types." This chapter is profusely illustrated, and all of the well known [illegible] are shown. Such cross-section illustrations as given on pages [illegible], [illegible] and 211 are especially to be commended.

rather than the catalogue illustrations so frequently given. Although many pages are spent on description of "bucket" turbines, which latter can hardly hope to compete with the purely re-action, or the combined nozzle and re-action types, yet no room is given to the Ljungström turbine which is such a feature in the recent volume on "Steam Turbines," by Goudie, of the London University. The chapter on "Governing" is excellent, but the succeeding one on "Marine Turbines" can hardly be said to approve itself to our English designers. The details of tests on steam turbines give examples of low power only, viz., from 500 to 1,000 kw., and therefore, do not bring out the really great superiority of this form of prime mover, in that it is without a rival in economy for large units. It would be very interesting to compare the detailed test sheet (on page 364) of a 400 kw. machine with a similar test sheet for a 25,000 kw. turbine unit. A una-flow reciprocating steam engine of [illegible] gives a thermal efficiency of 17·5 per cent. on a brake horse-power basis, and the figure given for the 400 kw. machine is 17·4 per cent., practically the same, but there is no reciprocating steam engine that can compare with the economy of the large unit. The pages devoted to turbine [illegible] are very interesting, but, like all financial problems, there is much that is debateable. In conclusion, this volume is one for the undergraduate or the graduate (using these terns as applicable to university students and practical men alike), rather than to post-graduate students or turbine design specialists. It can be recommended to all who desire to understand the construction and working of a steam turbine. Praise is due to the publisher for the excellence of the type, quality of the paper, and clearness of the illustrations. A. J. M.

Electrical Engineering Practice. By J. W. Meares. 3rd Edition. (London: E. and F. N. Spon. Pp. xx. + 642. 25s. net.)

This work appeared originally under the title of "Electrical Engineering in India," and was reviewed at some length in our columns as recently as April 23, 1915. In our present notice, therefore, we do not propose to go into the work in detail. We may mention, however, that the revision of the present edition has been carried out by Mr. R. E. Neale, who has re-written the chapter on "Electricity in Mines," and has contributed a new chapter on "Electric Automobiles," in addition to a considerable amount of other new matter, particularly in regard to motors.

Notes on Three-Phase and Ward Leonard Winding Equipment.*

By A. L. BALLARD.

The broad principle has been established, that either the Ward Leonard or three-phase system of electric winding may have advantages over the other according to the conditions of the wind.

The Ward Leonard system gives cheaper operating costs under nearly all conditions of wind, but the difference is only sufficient to counterbalance the higher capital cost when the accelerating and reverse power energy form a large proportion of the total energy consumption. With the three-phase equipment the present limit of size is about 2,000 H.P. at 2,200 volts. This is much too small for many deep level winding problems. Generally speaking, the three-phase equipment will be found economical on straightforward winds of moderate depths and weights. For plain cylindrical drum hoists hauling from 3,000 ft. is about the limit for economical three-phase work, provided that the R.M.S. horse-power does not exceed 2,000. For incline shafts the limit of depth will be much greater and will depend upon the angle of inclination.

For greater depths than 3,000 ft., probably up to 4,000 ft., there will not be much to choose between the two systems, and above this depth the advantage will be with the Ward Leonard equipment. The reasons for this are, firstly, the unbalanced pull on the drum becomes very great with great depths, needing a large accelerating peak, and, secondly, when nearing the end of the wind the unbalanced pull of the rope is more than enough to pull the skip to the surface and the winder will require reverse power to bring it to rest.

For shallow winds up to, say, 1,000 ft., the proportion of accelerating time is very large, and it becomes possible to save a large percentage of the power consumption by using a Ward Leonard equipment, in general sufficient to compensate for the extra capital that is required to install it.

Mr. A. H. O. [illegible]† brought out very clearly the effect of the duty that the winder had to perform on the [illegible] charges per trip. The [illegible] of the number of trips per annum and the longer the life of the [illegible] the [illegible] charges per trip, and the more chance for the Ward Leonard equipment to justify its extra capital cost.

[illegible] of high cost, but the rotors would have a very large moment of inertia, requiring large accelerating and retarding peaks.

Providing that the problem of gearing could be satisfactorily solved, large conical drum hoists, with geared three-phase motors, should prove economical for many propositions.

The effect of the cone is, generally speaking, to lower the peaking during the acceleration of the drum, which is of great benefit to the three-phase equipment. If the main peak comes after the motor has attained full speed the three-phase motor will supply that peak more economically than a Ward Leonard equipment could do. The ideal conical drum would be one in which the rope was wound round a very small diameter while the drum was accelerating before mounting the cone, thus the rotational accelerating peak would be separated from that due to acceleration of the rock skip and rope, also the balancing effect would be much more pronounced. The advantages to be gained by the use of a conical drum may be entirely lost if the conditions necessitate hauling from several different levels. The further apart the levels are situated the worse will be the conditions for a conical drum.

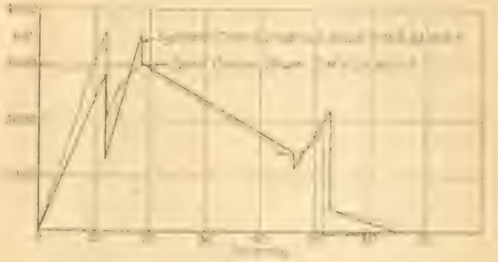


Fig. 1.

[illegible]

[illegible] case illustrated it is actually higher.

[illegible] operation under very severe conditions. The objections to them are:—

(1) [illegible]

(2) [illegible]

* [illegible]

† [illegible] 1911.

(*c*) Extra supervision and inspection necessary to guard against failure of rope.

(*d*) Impossibility of winding in only one compartment if the other is under repair.

The advantages to be gained by the use of a tail rope are considerable, and certainly increase the range of depths and loads for which three-phase equipments are suitable. By making the tail rope heavier than the winding rope the peak at starting and stopping is reduced. There are several three-phase tail rope equipments in operation up to 4,000 ft., and giving great satisfaction with economy of power.

[illegible] *Ropes.*—The importance of the factor of safety of the ropes in its bearing on the peak and R.M.S. horse-power has not been fully realised. In South Africa the minimum factor of safety, where hauling men, is fixed by Regulations of the Mines Department at six. For shallow mines this is by no means too high, but in the case of very deep shafts this minimum very soon limits the load that can be lifted.

Fig. 2 shows the difference in peak and R.M.S. horse-power for two equipments hauling the same loads from 5,000 ft., the one with an initial factor of safety of 7·75, and the other with an initial factor of safety of 6·17. The effect of the higher factor of safety, as far as the winder is concerned, is, first, larger unbalanced pulls

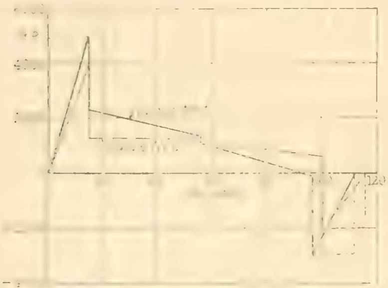


FIG. 2.—[illegible] HORSE-POWER TIME CURVES FOR 2 IN. AND $1\frac{5}{8}$ IN. ROPES.

[illegible]

Curve No. 1.	Curve No. 2.
Rope 2 in. diam., 6·5 lbs. per ft.	$1\frac{5}{8}$ in. diam., 4·37 lbs. per ft.
[illegible]	[illegible]
[illegible]	131 tons.
[illegible]	6·17.
[illegible]	10 ft. to 24 ft.
Cyclic time, 172.	[illegible]
R.M.S., H.P. 2,450.	[illegible]
[illegible]	[illegible]
R.P.M., 37·1.	[illegible]

necessitating larger motors and larger energy consumption, especially [illegible] owing to the larger amount of reverse power; second, larger drums necessitating lower speed motors, and therefore, higher capital cost and larger amortisation [illegible]. These are brought out in the diagrams. The [illegible] of the two equipments, [illegible] given to show that the effect of the high [illegible] on the running costs and capital costs is of considerable importance when dealing with shafts of great depth.

[illegible] of [illegible]

[illegible]

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]

[illegible]

stress can be calculated very exactly for any point in the rope, and is of course a maximum at the headgear sheave and gradually diminishes towards the point of attachment of the skip.

3. Stress due to normal acceleration is also capable of fairly exact determination, and will be a maximum at the headgear sheave. Provided the normal acceleration is a fixed quantity this stress could be included with No. 2 for the purposes of any regulation that might be framed.

4. This section needs sub-dividing, as it is of considerable importance.

(*a*) Shocks due to baling and to dropping the cage on to keps. This no doubt often does introduce severe stresses, and with a careless driver the stresses may easily be double the normal. It can be limited by care on the part of the driver, and by introducing some form of shock absorber between rope and cage or skip. In deep shafts the elasticity of the rope is sufficient to minimise the shocks very considerably. Baling, though unfortunately necessary at some shafts, is undoubtedly very bad for the ropes.

(*b*) Shocks due to loading the skips. These are very severe at times, especially in shallow shafts. When a load of four or more tons of rock falls into a skip it must produce stresses very much above those due to the dead load. The deeper the shaft the less the stress from this cause will be.

(*c*) Stresses due to vibration and whipping of the rope. The exact nature of these stresses is uncertain, but they will undoubtedly be worse just above the point of attachment of the skip, where the vibrations are reflected back along the rope. The stresses due to this cause will be alternating in value, and as such will tend to produce crystallisation of the metal of the wire with its attendant brittleness.

The causes of fracture of a rope may be divided into four groups:—

(1) Accidental damage; (2) deterioration due to corrosion by the acid water of the mine; (3) actual wear of the rope due to abrasion; (4) fracture of individual wires due to crystallisation and brittleness of the metal.

The factor of safety as calculated by the rules laid down in the Regulations of the Department of Mines cannot be considered a true factor of safety, though undoubtedly the limiting factor of safety placed as high as it is, viz., six for men, is a fairly good guarantee of safety for the men dependent on that rope. There are so many factors not taken account of by the Regulations that have a very considerable influence on the stresses set up in the rope, that it is possible for one rope with a higher legal factor of safety than another to have a lower real factor of safety than the one with a lower legal factor of safety. Ropes working in deep shafts are less liable to shocks than those in shallow shafts, and similarly those used in connection with electric winders have a more even accelerating stress than those used with steam winders. Neither of these factors is taken account of in the Regulations.

Industrial Reconstruction.

The inaugural meeting of the Industrial Reconstruction Council took place at the Guildhall, London, on Friday last, the Right Hon. Lord Burnham, C.H., occupying the chair.

The LORD MAYOR OF LONDON opened the proceedings by welcoming those present. These, in addition to the various speakers, included the following:—

Sir Herbert Bartlett, Bart., Mr. Alfred Bigland, M.P., Sir Robert Blair, LL.D., Sir Edward F. Coates, Bart., Sir Jeremiah Colman, Bart., J.P., D.L., Lieut.-Col. Sir William Earnshaw Cooper, Sir Clifford Cory, Bart., M.P., Sir George H. Fisher Smith, Sir Richard Garton, Sir William Grey Wilson, K.C.M.G., Sir Robert Hadfield, Bart., F.R.S., Mr. Lewis Haslam, M.P., Sir Frank Heath, K.C.B., Hon. J. G. Jenkins, Sir Sidney Low, Sir William McCormick, LL.D., Sir Herbert Morgan, K.B.E., Sir [illegible] Parker, M.P., Mr. De F. Pennefather, M.P., Sir J. D. Rees, K.C.I.E., Major Sir Thomas B. Robinson, K.C.M.G., K.B.E., Sir Alexander [illegible] (Ministry of Reconstruction), Mr. Leslie F. Scott, K.C., M.P., Rt. Hon. Sir Albert Spicer, Bart., M.P., Sir Arthur Spurgeon, Mr. [illegible], M.P., Mr. George Terrell, M.P., Mr. George R. Thorne, M.P., Mr. Robert Tootill, M.P., Sir Harry Wilson, K.C.M.G.

Mr. ERNEST J. P. BENN (Chairman of the Industrial Reconstruction Council), in explaining the objects of the formation of the Council, said [illegible] body of enthusiasts banded together to push one [illegible] thought which it was believed would help [illegible] some of the industrial problems now [illegible]. There was something which was called a trade, [illegible] quite apart from those engaged in it. That [illegible] attention and thought in the past [illegible] had been monopolised by such questions as capital and labour, profits and wages, masters and men; all our thoughts had been given to the differences existing between the

various parties in industry, and too little study had been given to industry itself. But when we talked of *our* trade, everybody thought at once of his own pocket, and his own convenience. The trade union and the trade association were gradually teaching us better, and we were now beginning to realise that there was a national interest in every trade, that each trade was a part of the social organism, a part of the national life. It was the duty of all those engaged in a particular trade—capital, management and labour—to join hands for the study and betterment of that trade. The Council advocated the general adoption of the recommendations of the Whitley Report. The output of most of our trades could be many times increased by proper attention to education, scientific research, statistical research, and the study of markets. None of these things had received proper attention in the past. They called for co-operative action. Industrial self-government, a trade parliament in every trade, would permit of regular discussion of all these and many other matters. A serious beginning would be made with the work of dispelling the ignorance which was the cause of most of our trade troubles. To-day we had an exceptional opportunity to make a beginning, because there was a vast amount of reconstruction work urgently waiting attention. Our traders must either submit to a continuation of the system of centralised bureaucratic control, or they must produce self-governing authorities able and fitted to take over these functions. Industrial prosperity depended upon industrial peace, and the first necessity of the future was a better understanding between employers and employed. Both parties were asked to join in a study of the betterment of our trades, and to work together on those great national matters upon which there was no room for difference of opinion, and in which both had an equal interest. The Industrial Reconstruction Council set out to-day, starting with the old City of London, to preach the doctrine of self-government for industry, the complete organisation of every trade, every man in his union, every employer in his association, and from the two an elected trade parliament in each industry, with proper official status and adequate powers. In this way the great fund of public spirit which existed within our trades, and which our present methods had entirely failed to realise, would be brought out. We should get nearer to the ideal when industry was recognised as one of the highest forms of national service, and something would then have been done to lay the foundations of peace and prosperity in the future.

The Right Hon. CHRISTOPHER ADDISON, M.P. (Minister of Reconstruction), said he was glad to have the opportunity of being present at that, the first formal meeting of the Council, because the [illegible]

[illegible]

The Right Hon. [illegible]

[illegible]

The Right Hon. J. H. WHITLEY, M.P., also advocated immediate action in regard to industrial reconstruction. The committee which drew up what was called the Whitley Report believed many of the most difficult of the war problems could have been solved with half the trouble and double the efficiency if the trades had had organisations such as they had recommended. He had had more applications for copies of the committee's report from officers and men in the trenches of the various fields of military operations than from people at home, and to his mind that threw a tremendous responsibility upon those at home to achieve the plan recommended in the report.

Mr. ERNEST BEVIN (Dock, Wharf, Riverside and General Workers' Union) referred to the awful poverty and brutally inhuman conditions that had been imposed upon his class. The workers had been forced to strike when they had been met with the adamantine opposition of employers. If labour was to be asked to take responsibility during the reconstruction period it must be given equal status in regard to the management of the whole industry.

Sir WILFRID STOKES, K.B.E. (President of the Industrial Reconstruction Council), moved: "That this meeting [illegible] the proposals of the Industrial Reconstruction Council, as a practical means of giving effect to the suggestions of the Whitley Report."

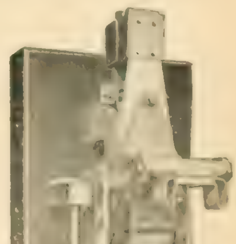
Sir HERBERT NIELD, K.C., M.P., seconded the resolution, and it was carried unanimously.

On the motion of Dr. WILLIAM GARNETT a vote of thanks was accorded to Lord Burnham for presiding.

B.T.H. Automatic Circuit Breakers.

A descriptive list issued by the British Thomson-Houston Co., Ltd., refers to some recent forms of automatic circuit breakers for alternating and continuous currents, with capacities up to 6,000 amperes, although the B type can be supplied up to 10,000 amperes. Fig. 1 shows a typical 1,200-ampere single-pole circuit-breaker. This is of form A, adapted to both alternating and direct current, and suitable for voltages up to 650. This is fitted with reverse current and time-limit overload attachments. A second type B is suitable for similar pressures, but for direct current only.

Fig. 2 shows a 2,000-ampere single-pole circuit-breaker (Type B) with overload and time-lag attachments, and fitted with patent blow-out shield.



[illegible]

[illegible]

Legal Intelligence.

Littleborough Urban Council v. Victoria Dyeing Co (Ltd.)

At the Chancery Court, in Manchester, last week, Littleborough [illegible] claimed that an agreement made by them with the Victoria Dyeing Co. was in force and valid for the full term, or, alternatively, that they were entitled to repayment of a proportion of the capital expenditure incurred in connection with it. The agreement in question bound the Council to supply electricity to the Uber Mill at Littleborough for 10 years from April 1, 1915, at specified prices, and £1,729 was expended in the provision of cables and other fittings. On Sept. 26, 1916, the mill was accidentally destroyed by fire, and the Ministry of Munitions would not grant permission to rebuild. Under these circumstances defendants contended that the destruction of the mill put an end to the agreement.

Mr. ATKINSON, K.C. (for the Council), said it was a case in which it was reasonable the parties should meet. They had agreed to split the claim, and there would be judgment for plaintiffs for £750 and costs, with liberty to remove the service cable or, alternatively (at defendants' option), to be paid an additional £50.

Tramway Passengers and Overtaking Vehicles.

Sheriff [illegible], in the Local Sheriff Court, has given effect to a by-law of Glasgow Corporation explicitly enjoining that vehicles approaching in the same direction as a tramcar must stop to allow tramway passengers to alight at stopping stations. The matter came up in connection with an appeal by defenders against Sheriff-substitute Moffatt's decision awarding David Cutler £35 for injuries sustained through being knocked down by a motor car belonging to Sym & Co. The pursuer was alighting from a tramcar at a stopping station, and defenders pleaded that he contributed to the accident by failing to look to see if any vehicle was approaching.

The Sheriff affirmed the decision appealed against.

Patent Record.

SPECIFICATIONS PUBLISHED.

The [illegible] of the specifications recently published have been [illegible] MARKS & CLERK, ELLIS & PRYOR, Chartered Patent Agents, [illegible] W.C.

[illegible] from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

[illegible]

[illegible] Electric motors. (10/10/16.) [illegible]

[illegible] SAVILLE. Electrodes for storage batteries. (11/10/16.) 112,476

[illegible] (16/6/14.) [illegible]

15,010 [illegible] (28/7/14.) [illegible]

17,476 [illegible]

[illegible] each phase of a multiphase source a choking coil wound on a closed (or nearly closed) [illegible]

[illegible] oduction of alternating currents of different [illegible]

A machine for the conversion of frequency, or for the simultaneous production, [illegible] series, the bars being spaced apart by a pole space of the field, while the winding acted on inductively by the field having the smaller number of poles is connected [illegible]

[illegible]

3,360 FLEMING. Telegraphic relays. (7/3/17.) 112,544.
3,437 B.T.-H. CO. (G.E. Co.) Systems of electric motor control. (8/3/17.) 112,545.
3,914 IMRAY. (Bosch Magneto Co.) Magneto-electric ignition machines. (17/3/17.) 112,547.
4,418 RAILING, SOLOMON & ANGOLD. Electric arc lamps for projection purposes. (27/3/17.) 112,552.
4,790 SPILLER, PATTON & HURST. Electric ignition plugs for internal combustion engines. (3/4/17.) 112,556.
5,292 B.T.-H. CO. (G.E. Co.) Electric regulators. (14/4/17.) 112,708.
5,941 BUTLER, H. B. Electric switches. (27/4/17.) 112,711.
7,092 NICHOLLS, E. G. Electric fuses. (17/5/17.) 112,717.
7,629 BOURGOGNON, R. L. A. Sparking plugs for internal combustion engines. (26/5/17.) 112,720.
8,470 PAILIN & FERGUSON, PAILIN & CO. Electric switchboards. (13/6/17.) 112,580.
8,792 VIOLET. Ignition device for explosion motors. (23/6/16.) 107,388.
9,169 WILD, L. W. & BARFIELD, E. P. Electrical furnace for hardening steel and the like. (26/6/17.) 112,731.
9,558 ADAMSON, E. Electrically operated rivetting, pressing, stamping and the like machines. (3/7/17.) 112,733.
10,896 DRESCHER, C. P. Electric switches. (28/7/17.) 112,740.
14,402 BOUDREAU, H. L. Spark-plugs. (2/6/17.) 112,752.
14,446 SUBMERSIBLE & J.-L. MOTORS & DURNFORD. Electric motors. (10/10/16.) (Divided application on 14,417/16.) 112,602.
15,488 S. [illegible] FRANÇAISE RADIO-ELECTRIQUE. Radiotelegraphy or radiotelephony. (24/10/17.) 112,607.
18,069 STERLING TELEPHONE & ELECTRIC CO., BELL & DAVEY. Electrical signalling systems. (Divided application on 306/17.) 112,610.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

January 30, 1918.

1,728 HOSKINS. Enhancing radiation or diffusion of light from electric lamps, &c.
1,757 B.T.-H. CO. (G.E. Co.) Wireless signalling systems.
1,765 ROBIN. Cells of electric batteries.
1,766 WATT. (Scott.) Supporting and attaching electric cables to insulators.

January 31, 1918.

1,773 FULLER ACCUMULATOR CO. & WELCH. Variable speed dynamo-electric machines.
1,790 LAMB. Insulators for supporting electric conductors.
1,794 RYLAND. Magnetic compasses, &c.
1,795 KUYSER. Protecting devices for A.C. apparatus.
1,833 VANDERVELL & HETTINGER. Telegraph, &c., instruments and installations.

February 1, 1918.

1,847 SANDERS. Electric bracket for dashboard lighting on aeroplanes.
1,852 JOHNSON. Galvanometers, &c.
1,865 RUTHERFORD. Device for stopping a motor or giving warning when an obstruction occurs between armature and magnets.
1,879 MARKS. (Huttenwerk Niederschöneweide A.G.) Electrolytic baths.
1,886 B.T.-H. CO. (G.E. Co.) Wireless signalling systems.
1,894 K.W. IGNITION CO. Connections for electric conductors. (12/7/17, U.S.)
1,895 K.W. IGNITION CO. Circuit-breakers for ignition systems. (23/7/17, U.S.)
1,896 WHITE. (Industrial Elec. Furnace Co.) Electric furnaces.
1,903 HENRY. Electrical magnetic drive and clutch.
1,905 BARFIELD & WILD. Indicating condition of steel, iron and other magnetisable metal during heat treatment.
1,907 JOHNSON. (Commercial Triuck Co.) Secondary batteries.

February 2, 1918.

1,915 SIMPLEX CONDUITS (LTD.). & WATERHOUSE. Watertight plug and socket fittings for electric connections.
1,918 ELECTRIC & ORDNANCE ACCESSORIES CO. Self-starters for engines.
1,919 RUNBAKEN. Magneto-electric machines for use with internal combustion motors &c.
1,929 SECKERSON. Generation of power, light and heat from the tide.
1,937 NIX. Armatures and coils for magnetos, &c.
1,962 BASTIAN. Electric glow-lamp sockets.

Volunteer Notices.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Oxford-street, W. 1.

Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.

Orders for the Week.

Officer for the Week. Lieut. P. Bowden.

Next for Duty. Lieut. W. J. A. Watkins.

Monday, Feb. 25.—No. 3 Company, 6.30-8.30. Recruit's Drill, 6.30-8.30 Signalling Section, 6.30-8.30.

Tuesday, Feb. 26. Lecture on Demolitions at 6.30. Physical Drill and Bayonet Fighting, 7.30.

Wednesday, Feb. 27. No. 1 Company, Knotting, &c., 6.30-8.30. Recruits' Drill, 6.30.

Thursday, Feb. 28. No. 2 Company, Knotting, &c., 6.0-8.0. Recruits' Drill, 6.30-8.30. Signalling Section, 6.30-8.30. Ambulance Section 6.30-8.30.

Friday, March 1.—Musketry, 5.30-8.0.

Saturday, March 2. Entrenchments, &c., for the whole Corps, 2.15-4.45. Recruits' Drill, 2 to 4.45.

[illegible] Notices. All drills will take place at headquarters unless [illegible]

[illegible] will attend for Engineering Instruction with the Companies. [illegible] officers will attend on Thursday evening for the examination [illegible]

[illegible] a band under the direction of Mr. Chas. Bailey, as [illegible] having been approved by the Commandant, any members [illegible] their own instruments and [illegible] instrument if instructed, are invited to [illegible] to the Adjutant at Headquarters without delay.

Commercial Topics.

The Engineering Trades' (New Industries) Committee.

In our issue of the 1st inst. we announced the appointment of the above Committee and the scope of its work. A number of branch committees, each of which will consider a certain trade or group of trades, have already been set up. We are pleased to note that Mr. John Taylor, of Messrs. Mather & Platt (Ltd.) has been oppointed chairman of the Electrical Branch Committee. Those of our readers who have any specific recommendations to make under the terms of reference concerning the electrical industry should address their communications to Mr. J. Taylor at Room 114, Armament-buildings, Whitehall-place, London, S.W. 1.

* * * *

Trade Marks.

The Trade Marks Committee of the Federation of British Industries has decided to oppose Part II. of the proposed new Government Bill "To Amend the Trades Marks Act, 1905," on the ground that it will inflict serious injury on the owners of perfectly legitimate trade marks. Part II. deals with "Provisions for the Prevention of Abuses of Trade Marks." The Committee also decided that the proposed British Empire Trade Mark should be opposed.

* * * *

Trade Organisations and Combinations.

The Minister of Reconstruction (Dr. Addison, M.P.) has appointed a Committee to consider and report what action (if any) may be necessary to safeguard the public interest in view of the probable extension of trade organisations and combinations. The members of the committee are :—

Mr. E. Shortt, K.C., M.P. (chairman), Messrs. Percy Ashley (Board of Trade), E. Bevin, J. H. Guy (Ministry of Munitions), J. A. Hobson, J. F. Mason, M.P., G. Scoby Smith (Messrs. Bolckow, Vaughan & Co.), W. H. Watkins, Sidney Webb, Douglas Wenham (Messrs. Wenham & Co., accountants), Birmingham.

Mr. John Hilton, of the Garton Foundation, will act as secretary of the Committee, and communications should be sent to him at 33, Dean's yard, Westminster, S.W. 1.

* * * *

Industrial Councils for Scottish Tramways.

At a meeting of representatives of Scottish tramway undertakings on Friday last, questions arising out of applications for advances in wages, war bonuses and the statutory limitation of tramway fares were discussed.

A resolution was moved in favour of the setting up of Councils to deal with these matters on a national basis, as suggested by the Whitley Report, but the meeting decided that these questions should be dealt with by areas instead of nationally, and an Executive Committee was appointed to take action on these lines and report to another conference.

* * * *

The Road Transport Board.

The President of the Board of Trade has appointed Sir Evan D. Jones, Bart., to be chairman of this Road Transport Board.

The members of the Board are Sir Maurice Bonham Carter, K.C.B., Assistant Secretary to the Ministry of Reconstruction; Colonel H. N. Foster, Assistant Director of Supplies and Transport, War Office; Mr. A. E. Kidner, principal clerk, G.P.O.; Sir Ernest W. Moir, Bart., a member of the Council, Ministry of Munitions; Mr. E. H. Selby, Controller of Horse Transport, Board of Trade; and Mr. H. S. Woodruffe, Director of [illegible] Branch, Ministry of Food.

* * * *

The Board of Trade Tramways Committee.

All the Area Sub-Committees of the above Committee have arranged for meetings of representatives of tramway undertakings in their areas, and five have been held this week. Other meetings will be held as under:

The South Wales area at Cardiff on the 26th inst., the South West and South at Bristol on the 26th inst., and the Metropolitan and East Coast and the South East and South areas at London on the 27th inst.

[illegible]

[illegible]

[illegible]

Mr. FELL (L.C.C. Tramways), who replied to the discussion, explained that whenever a matter of policy was raised, such as the suggested closing of a route or portion of a route and the subsequent lifting of the rails for transference to other sections, a local inquiry would first be held and the opinion of the local tramway committee or concern would be invited.

It was agreed to appoint an Advisory Committee, consisting of one representative from each tramway concern, and Major Coutts, Paisley, was appointed honorary secretary.

* * * *

Pre-War Contracts.

The Committee appointed by the Board of Trade to consider the position of British manufacturers and merchants in respect of pre-war contracts has issued its report, and recommends that, instead of the cancellation of pre-war contracts by legislation, or the granting of compensation, disputes should be settled by the parties.

In some cases an allowance might be made on the principle of indemnity, but no payment for loss of profits should be paid out of the public purse. Relief might also be given by writing off future losses against payments in respect of excess profits, &c.

Electricity Supply.

Extensions.

Derby.—The demand for electric power is increasing at a rapid rate, and amongst the applicants for supplies is the British Cellulose Co. To meet the increased demand, the Corporation is extending its plant and mains at an estimated cost of £87,000.

Dublin.—At a special meeting of the Corporation on Friday it was decided to apply to the L.G. Board for sanction to raise a loan of £50,000 for the purpose of equipping a new North Wall sub-station, the laying of e.h.t. mains, and the construction of a tunnel under the river. It was also agreed to apply for sanction to a further loan of £65,000 for distribution cables.

In future a small percentage of the cost of future extensions will be divided proportionately between the engineers, Messrs. Ruddle, Kettle and Archer.

Mr. J. J. O'Neill, chairman of the Electricity Committee, who moved the adoption of the Committee's report, said the engineers of the undertaking were of opinion that if the Committee did not get the loan in order to renew and extend the machinery at the Pigeon House, there was a danger that the lighting of the city might be imperilled next winter. Col. P. W. D'Alton, the engineer who had examined the plant, reported in 1916 that it would be imperative that further capital must be expended at the generating station to provide for the demands of the winter 1917-18, and that a scheme of extension must be prepared and completed during 1917. Their own engineers agreed with the opinion of Col. D'Alton, and stated that it was necessary that new and additional plant should be installed.

The Committee's report was adopted, as was a report recommending the purchase of an underfeed stoker for the Pigeon House station.

Dundee.—Negotiations are taking place between the Corporation and the Caledon Shipbuilding Co. for the erection of a sub-station on the company's premises.

The Corporation will supply h.t. current, which will be converted at the sub-station to suitable voltage for power and lighting purposes. The estimated cost of the sub-station is £7,000.

King's Lynn.—On the recommendation of the borough electrical engineer (Mr. C. W. Jackson), the Council have decided to apply for authority to extend the generating plant at the electricity works at an estimated cost of £15,000.

The Electricity Committee is in negotiation with the [illegible] for the supply of electricity to [illegible] works of the company.

Kingston-on-Thames.—The Corporation have decided to carry out extensions of their electric supply undertaking at a cost of £[illegible].

[illegible]

Stepney.—As stated in our last issue, the Electricity Supply Committee recommended the Council at its last meeting to erect and equip an additional sub-station at a cost of £52,000.

The engineer and manager (Mr. W. C. P. Tapper) in his report on the matter, stated that the north-eastern district of the borough, for which it is necessary to provide a sub-station, has been receiving supplies at very low pressure for over a year. During the past four years the demand on the Limehouse sub-station has increased by nearly 1,000 kw., and the l.t. feeders are carrying about 50 per cent. more than their rated capacity, resulting in the consumers receiving current at about 16 per cent. below the standard voltage of supply. The feeders are connected to the Limehouse station, which is acting as a sub-station for the north eastern district, as well as for the neighbourhood of Limehouse, where the local demand has also increased very rapidly during the last few years. The prolongation of the war and the sustained, and even increasing, demand for electric power supplies for factories, have made it essential for the sub-station to be provided without further delay. Unless this is done in time for next winter's load many important power users will be very detrimentally affected by inability to give supplies in their district at a pressure reasonably approximate to that for which their motors are designed, and a continuance of the overloading, and consequent overheating, of the Council's feeders may cause a serious breakdown of the cables, and in any case deterioration of the cables will take place. With regard to converting plant, immediate requirements would be met by the provision of one 1,000 kw. and one 500 kw. converter, with the necessary overhead crane, h.t. and l.t. switchgear, cables, &c. The existing h.t. feeder from Limehouse to Whitechapel would be cut, the two ends being taken into the proposed sub-station. A duplicate feeder would be required from the Limehouse station to the sub-station direct. The estimated cost of the work is as follows: Land, buildings, &c., £12,650; plant, £12,030; feeder cables, &c., £22,660; contingencies, £4,660; total, £52,000.

Mr. Tapper also referred to his previous report on after the war developments, in which a further extension of the Limehouse generating station was anticipated. During the present winter the maximum load on the undertaking has slightly exceeded the maximum working capacity (*i.e.*, allowing for the necessary spare) of the generating plant installed at Limehouse, which, however, includes a supply of about 1,500 kw. to Shoreditch. Although no new consumers are being connected to the Council's mains, a further increase in the consumption within the borough must be expected next winter, due to extensions of existing installations and fuller utilisation of motors already installed. The question of further extensions at Limehouse may, therefore, become urgent at an early date.

Swansea.—The scheme for extending the municipal area of electricity supply to include the docks, &c., has received the sanction of the Government and has been given priority under scale 4.

Wimbledon.—The Council has decided to borrow a sum not exceeding £15,000 for the purpose of providing temporarily during the present year for the current expenses of the electricity undertaking.

General.

[illegible]

British Aluminium Company's Bill.—In a letter to the "Man- [illegible]

[illegible]

Devizes.—The Council in committee are to consider the question of obtaining a provisional order to enable them to supply electricity in the district.

Dublin Docks.—The Port and Docks Board have appointed a committee to deal with the question of the electrical equipment of the docks.

At the last meeting of the Board Dr. Sherlock said that in the immediate future the board should do either of two things. They should lay out substantial capital and provide new plant, cables, &c., or, in the alternative, get electricity in bulk from Dublin Corporation. The engineer suggested that the Corporation should sell the electricity at less than a penny a unit, and he pointed out that if they did that they would save £2,000 a year for maintenance, involving a capital expenditure of £10,000. The engineer also suggested that the board could sell after buying from the Corporation for its own use to clients and customers in their vicinity. The Port and Docks Board had no power to do that, and would break the law in supplying the Dublin Dockyard Co., but they were doing it to carry out works of national importance. It would be right to approve of the general principle of taking power from the Corporation at a price to be fixed upon afterwards. The price should be fixed on two bases: the nature of the load and the varying prices of coal. The Corporation were holding a special meeting with the object of approaching the L.G. Board with regard to the whole northern side of the quays, having regard to the revival of industries in Dublin. He proposed "That the board favours the suggestion of taking electricity in bulk from the Corporation at a price basis to be agreed on."

Mr. Field sceonded the motion, which was unanimously adopted.

Electrical Power Engineers' Association.—Mr. F. B. O. Hawes, hon. secretary The Electrical Trades' Benevolent Association, has been asked to address the Electrical Power Engineers' Association (the reconstructed A.E.S.E.) at its March meeting.

Applications from senior engineers above the rank of engineers-in-charge continue to come in, and to date the Association includes 45 chief assistants and chief technical assistants among its members.

A Selection Committee has been appointed consisting of the mains engineer and charge engineer from company undertakings and chief assistant and mains engineer from municipal undertakings.

Mr. H. E. Mortimer has been elected representative for Croydon on the Council of the Association.

An ordinary Council meeting will be held on Thursday, March 14, at 7 p.m., at St. Bride Institute, Bride-lane, Fleet-street, E.C.4.

Electric Power Supply.—A statement which has been prepared, by the Council of the Incorporated Municipal Electrical Association in conjunction with the Association of Municipal Corporations, in regard to the supply of electric power has been submitted to the Board of Trade Electric Power Supply Committee. We hope to give the terms of this statement in our next issue.

Revision of Charges for Electricity Supply.—In a communication, dated Feb. 12, the Minister of Munitions states he is advised that, in general, the business of electrical undertakings may be allocated to the following classes of consumers:—

(1) Consumers with long-term contracts at pre-war rates, and whose works are "controlled establishments"; (2) consumers with long-term contracts at pre-war rates and whose works are uncontrolled; and (3) consumers—both for power and light—supplied under contracts which are alterable by short notice. With regard to the first class, the Minister is of opinion that a reasonable advance in price should be paid for current supplied to controlled establishments provided (1) that, so far as possible, all classes of consumers shall be similarly dealt with—that is to say, that the burden shall be spread over all classes, although not necessarily by an addition of the same percentage advance in each case; (2) that the revenue resulting from an advance in prices shall, if more than sufficient to show the same return on capital as was earned during the financial year prior to the outbreak of war, after setting aside the same rate for depreciation or reserve, be dealt with in such manner as the Minister may decide; (3) that any advance in price under long-term contracts shall [illegible] only during the period of Government control, unless the con- [illegible] otherwise agrees.

With regard to the second class of consumers, the Minister is of opinion that [illegible] consumers should voluntarily comply with the demand of the public service undertakings for a temporary advance in price on similar [illegible] proposed in the case of the first class, and in this opinion the Board of Trade concurs. Should there be difficulty in securing consent to an [illegible] in price from uncontrolled establishments still paying [illegible] rates for current, procedure is open to the undertakers under the [illegible] Electricity Power Acts.

With regard to the third class of consumers, the Minister understands [illegible] and that as a [illegible] within the prescribed maximum prices which [illegible] but that in the case of [illegible] Order provide for a revision by the Board of Trade of the maximum prescribed, it is understood that the [illegible]

[illegible]

Marylebone (London).—At the last meeting of the Council the following resolution of the Electric Supply Committee was passed unanimously, and the common seal of the Council was ordered to be affixed thereto, viz. :—

That this committee do place on record its high appreciation of the important services rendered by Mr. E. J. Jennings to the St. Marylebone electricity undertaking, together with its keen regret at losing his services. During the 13 years Mr. Jennings has acted as secretary and accountant of the undertaking he has displayed a business capacity, a grasp of detail and an imaginative insight that have been invaluable to the undertaking during many difficult years, while successive chairmen of the committee have testified to his unfailing courtesy and untiring interest in his duties. The committee desire to congratulate Mr. Jennings on his appointment to a very responsible post at Birmingham, and to express their good wishes for his success and happiness in his new work.

Salford.—The Corporation have increased the salary of the borough electrical engineer (Mr. J. A. Robertson) by three annual advances of £100, £100 and £50 respectively to a maximum of £1,250, the first advance to commence as from April 1, 1917.

The Corporation have also adopted a scale of salaries under which the maximum salaries of the staff will be increased as follows :—The Deputy Engineer from £340 to a maximum of £500 per annum, the Mains Engineer from £300 to £375, the Station Superintendent from £250 to £375 and the Charge Engineers from £200 to a maximum of £250 per annum.

Standing Conference of Electricity Supply Associations.—Mr. H. Faraday Proctor, of Bristol, notifies us of the formation of the above conference in order that there may be one single body representative of the whole of the electricity supply undertakings throughout the kingdom, whether municipal or company owned.

The conference is constituted as follows: Incorporated Municipal Electrical Association (representing 196 municipalities), the Conference of Chief Officials of London Electric Supply Companies (representing 13 companies in London), the Incorporated Association of Electric Power Companies (representing 11 power companies in the provinces), and the Provincial Electric Supply Committee of the United Kingdom (representing provincial companies).

The conference will deal with matters relating to conditions of employment, the rates of remuneration of staff and employees, and other matters of general concern. The hon. secretary of the Standing Conference (Mr. H. Faraday Proctor) requests that the earliest advice possible be given to him in connection with all such matters to enable the provincial as well as the London representatives to receive timely notice.

Electric Traction.

Discharged Service Men as Motormen.—In order to safeguard the public from tramcar accidents through the employment of discharged service men, the Board of Trade has issued a recommendation to local authorities [illegible]

Electrically Driven Motor Vehicles.—[illegible] electricity in motor vehicles.

Great Central Railway.—[illegible]

Middlesbrough.—[illegible]

Southport.—[illegible]

[illegible]

Miscellaneous.

Enemy Firm Wound Up.—[illegible]

Trading With the Enemy.—[illegible]

Wages in the Electrical Trade.—It was reported to the London County Council on Tuesday that the Committee on Production had issued a finding, dated Jan. 7, 1918, awarding (inter alia) 5s. per full ordinary week to the men concerned in the electrical trade as from the beginning of the first full pay in December, 1917, such amount to be regarded as a war advance.

The present finding makes the minimum amount of the total advance on pre-war rates 20s. a week. There was some obscurity as to the effect of previous agreements and awards on the wages of men in the trade, and the present award appears to clarify the position.

The recent decision of the Chief Industrial Commissioner regarding the application of the $12\frac{1}{2}$ per cent. bonus on earnings in the electrical trades, affects electrical contractors' employees engaged on munitions work as from the beginning of the first full pay after Oct. 13, 1917. The award of the Committee on Production and the decision of the Chief Industrial Commissioner are to be recorded in the Council's list of rates of wages and hours of labour.

Educational.

University of Manchester.—Messrs. Simon Carves (Ltd.) have founded a research scholarship in chemistry of the annual value of £100.

Proposed University for Nottingham.—The Council of Nottingham University College recommend that steps be taken to obtain a new charter creating the college a modern university.

It is proposed to ask the City Council to transfer the present site and buildings to the governing body of the new university and to provide £15,000 annually for the maintenance of the university. It is proposed to raise £150,000 by voluntary subscriptions in the East Midlands for the further endowment of the proposed university.

Manchester School of Technology.—Some large firms engaged in the principal industries of the Manchester district have offered to the governing body of this school £3,000, spread over a period of five years, towards the cost of establishing a new department of industrial management.

The Manchester Educational Committee recommend that the gift be accepted, and have expressed their appreciation of the public spirit of the donors. It is proposed that a lecturer shall be appointed for five years at a salary of £600 per annum, to conduct research in the subject of industrial management, to organise the new department, to lecture to members of the University and to the public, and to assist industrial concerns in the solution of management problems, &c. It is proposed to invite a number of managers, directors, scientific experts and others with special experience to deliver popular lectures.

Tenders Invited and Accepted.

Electrical Stores.

BELFAST Tramways and Electricity Committee invite tenders for the supply of materials, including lubricating oils and petrol, ironmongery, v.b. insulated cable, v.i.r. cables and wires, electrical [illegible] bitumen, bitite strip, prepared tape and rubber tape, joint box com[illegible]

Tramway Stores.

[illegible]

Electrical and General Stores.

[illegible]

Railway Stores.

[illegible]

Wiring and Fittings.

[illegible]

Wolverhampton.—The Corporation has accepted the following tenders: Willans & Robinson, spare parts for the 3,000 kw. turbine set, £158. 8s.; Gibbons Bros., steel chequer flat flooring, £78; also shelter house for the new telpher machine, together with platforms, ladders, skip dumping rails, &c., £157; Lea Recorder Co., one water measuring recorder, £97. 16s. 6d.; A. Reyrolle & Co., switch panel to control a rotary converter, £434.

Melbourne.—The tender of the Australian General Electric Co., amounting to £39,720, for the supply of electric lighting plant and apparatus for car lighting has been accepted by the Melbourne Tramways Board.

Government Contracts.—The following tenders were accepted by the British Government Departments during January:—

[illegible] H. T. Beetroyd (Ltd.), Electrical Apparatus Co., Electric Construction Co. and Mather & Platt, motors, &c.; Ellis & Ward & Jackson & Boyce, electric lighting.

H.M. Office of Works.—Siemens Bros. & Co., electric bell fittings.

Post Office.—British L. M. Ericsson Mfg. Co., protective apparatus; Isenthal & Co., telegraph apparatus; Peel-Conner Telephone Works, telephone apparatus; Evershed & Vignoles & Reid Bros. Engineers, Ltd., testing apparatus; British Insulated & Helsby Cables, General Electric Co., W. T. Henley's Telegraph Works Co., Johnson & Phillips, Cl Macintosh & Co. Pirelli General Cable Works, Siemens Bros. & Co., and Western Elrctric Co., telegraph cable. Western Electric Co., British Insulated & Helsby Cables, Peel-Conner Telephone Works, and Phœnix Telephone & Electric Works, telephone cords; British Insulated & Helsby Cables, cable distribution plugs; Bullers (Ltd.), insulator spindles and stay swivels; T. Bolton & Sons and British Insulated & Helsby Cables, Shropshire Iron Co. and F. Smith & Co. (inc. in London Electric Wire Co. & Smiths, Ltd.), [illegible]

Public Works (Ireland).—Andrew Stevenson, electrical works and supplies, Belfast district.

Appointments Vacant and Filled.

A teacher is required to give lecture and laboratory instruction in the applied electricity classes at the Birmingham Municipal Technical School. Particulars from the Secretary, Suffolk-street, Birmingham. *See advertisement.*

A London supply authority requires a meter test room assistant. Wages 35s., plus 12½ per cent. bonus. *See advertisement.*

A junior shift engineer is required for large power station in the north. *See advertisement.*

A test-room superintendent is required for a Corporation electricity department in the north of England. Salary £225 per annum. *See advertisement.*

A power-house superintendent is required for a Corporation electricity department in the north of England. Salary £350 per annum *See advertisement.*

Mr. E. Cloney, district traffic superintendent, has been promoted to be a divisional superintendent in the traffic branch of the L.C.C. tramways department at a commencing salary of £325 a year, rising by annual increments of £25 to £400 a year.

Business Items.

Gas and Oil Fired Furnaces.—The Davis Furnace Co., Luton, have [illegible] pamphlet giving particulars of their gas and oil fired furnaces.

Patent Development.—The proprietor of Patent No. 4,228 of 1909, for "Improvements in Electric Cutouts," desires to make arrangements for exploiting same in this country. Applications to Messrs. H[illegible] & Co., chartered patent agents, 28, Southampton-buildings, Chancery-lane, London, W.C.

Plant Wanted.—An advertiser wants two 250 H.P. direct-current [illegible] Bellis) engines and switchboard.

Plant for Sale.—Barrow-in-Furness Corporation advertise for sale [illegible] and switchboard. Further particulars [illegible] from the electrical engineer, Mr. H. R. Burnett.

Companies' Meetings and Reports.

BRITISH INSULATED & HELSBY CABLES (LTD.)—[illegible]

[illegible]

to 6 per cent.; and accumulative sinking fund be established so that by purchase or drawings these debentures be all repaid during the extended currency. (2) That the unsecured debentures be converted at par into 7½ per cent. cumulative preference shares, with a right contingent on the profits of each year to participate to the extent of a further 2½ per cent.

CENTRAL ELECTRIC SUPPLY CO. (LTD.)—The accounts for 1917, including amount brought forward, and after payment of interest on debenture stock, placing £20,636 to depreciation fund and writing off £457 discount on issue of debenture stock, show a credit balance of £16 to be carried forward. Last year £19,557 was placed to depreciation fund and £1,257 written off discount on issue of debenture stock. 33,873,437 units of electrical energy were supplied to the Westminster Electric Supply Corporation, the St. James' and Pall Mall Electric Light and Chelsea Electricity Supply Companies.

CENTRAL LONDON RAILWAY CO.—For the year 1917, the Company's share of the common fund established under the common fund agreement of Dec. 21, 1915, is 20 per cent. (£104,067 7s. 6d.), and this sum, plus £12,079 7s. 11d. brought forward, makes a total of £116,146 15s. 5d., which is available for dividends on the ordinary, preferred ordinary and deferred ordinary stocks. The gross receipts of the railway for the year was £351,289, and the expenditure was £192,465, and with miscellaneous receipts (£37,444) the total net income was £196,268. With £12,079 from last year, and after deducting interest, rentals and other fixed charges (£50,600), and appropriating £20,000 to reserve, and decucting dividend on preference stock (£21,600), the balance available is £116,147. The interim dividend of 1¾ per cent. on the ordinary stock and of 2 per cent. on the preferred ordinary stock for the half-year ended June 30, 1917, absorbed £42,704, leaving £73,443, which will admit of the payment of a dividend of 1¾ per cent. on the ordinary stock, of 2 per cent. on the preferred ordinary stock for the half-year ended Dec. 31, 1917, and of 3 per cent. on the deferred ordinary stock for the whole year, making 3½ per cent. on the ordinary stock and 4 per cent. on the preferred ordinary stock for the year, leaving £11,147 to be carried forward. The capital expenditure during the year amounted to £47,746. The construction of the extension railway between Wood Lane and Ealing Broadway cannot be further proceeded with at present owing to the war. The conveyance of parcels by train and delivery by cycle messenger service from the stations, has been discontinued during the year, owing to unsatisfactory financial results, as well as to the difficulty in obtaining the staff necessary to work this service.

CITY & SOUTH LONDON RAILWAY CO.—Under the terms of the common fund agreement of Dec. 21, 1915, the Company is entitled to 6 per cent. of the fund (£31,220 4s. 3d.) for the year 1917, and this sum, plus £17,245 7s. 5d. brought forward, makes a total of £48,465 11s. 8d. The gross receipts of the railway were £258,233, and the expenditure was £141,185. With miscellaneous receipts (£25,275), the total net income was £142,323. Adding balance from last year (£17,245), and deducting interest, rentals and other fixed charges £48,602, appropriating £20,000 to reserve, and deducting dividends on preference stocks (£42,500), the balance available is £48,466. The interim dividend paid for the June half-year on the consolidated ordinary stock was ¾ per cent. This absorbed £11,100, and leaves £37,366, which admits of the payment of dividend for the half-year ended Dec. 31, 1917, on the consolidated ordinary stock, of ¾ per cent., making 1½ per cent. for the year. On account of the uncertain outlook, the enhanced prices of all materials and labour, &c., it is proposed to appropriate a further £5,000 to reserve, making a total of £25,000 for the year, and to carry forward £21,266. The capital expenditure during the year amounted to £11,142. The conveyance of parcels by train and delivery by cycle messenger service from the stations, has been discontinued during the year.

ELECTRICAL DISTRIBUTION OF YORKSHIRE (LTD.)—The net profit for 1917 was £3,693 against £3,495 in 1916 and £3,638 in 1915. After payment of directors' remuneration the balance forward from 1916 was £731, making the disposable balance £1,423. The directors recommend payment of a dividend (tax free) for 1917 at rate of 6 per cent. per annum on the ordinary shares (£2,727), adding £1,000 to reserve fund, and carrying forward £697. In 1916 the Board of Trade granted electric lighting provisional orders for Featherstone, Otley, Garforth, Penistone, Horbury and Rawdon. These orders were confirmed by Parliament, but will not come into force until after the termination of the war. In order to provide for the development after the war of the districts for which orders have been obtained, and to make extensions in those districts in which supply is now being given, the directors consider it advisable to increase the nominal capital of the company from £50,000 to £100,000.

ELECTRO BLEACH & BY-PRODUCTS (LTD.)—The directors have declared further interim dividends on account of 1917 of 3½ per cent. (less tax) on the preference shares (making 7 per cent.) and of 10 per cent. (less tax) on the ordinary shares. The negotiations between the Company and the Government in regard to the duties payable under the Finance Acts and the Munitions of War Acts have made considerable progress, and the directors hope that there will not be much further delay before they are in a position to issue the balance sheets for 1916 and 1917.

LONDON ELECTRIC RAILWAY CO.—For the year 1917, the aggregate [illegible] traffic receipts of the five Companies parties to the Common Fund Agreement of Dec. 21, 1915, were £[illegible]843,201 5s. 2d., and the aggregate gross receipts of the five companies from all sources were £[illegible]6,661,862 17s. 1d. The aggregate amount retained by the five companies for "revenue [illegible]" which includes working expenses, prior charges, reserves, &c., [illegible] and the balance (£[illegible]0,336 17s. 1d.) was credited to the [illegible] fund. Under the terms of the agreement the Company is entitled to 30 per cent. of the fund, or £1[illegible]6,101 1s. 2d. This sum, plus £[illegible] brought forward from last year's accounts, makes a total

of £180,575 5s. 11d. The gross receipts of the railway were £1,139,554, and the expenditure £611,892, and with miscellaneous receipts (£89,327) the total net income was £616,989. Adding balance from last year (£24,474) and deducting interest, rentals and other fixed charges (£298,941), appropriating £35,000 to reserve, and after paying the preference dividend (£126,947), the balance available is £180,575. The interim dividend for the half-year ended June 30, 1917, on the ordinary shares was ¾ per cent., which absorbed £69,960 and left £110,615. This admits of the payment of a dividend for the half-year ended Dec. 31, 1917, on the ordinary shares of ¾ per cent., making, with the interim dividend, 1½ per cent. for the year, as in 1916. On account of the uncertain outlook, the enhanced prices of all materials and labour, and the impossibility of securing all the materials required for the complete maintenance of the property during the past year, it is proposed to appropriate a further £10,000 to r serve, making a total of £45,000 for the year, and to carry forward £30,656. The capital expenditure during the year amounted to £9,348. In accordance with the arrangements referred to in the last report, the Company has provided the rolling stock for the through running of trains from the "Bakerloo" section of the railway to Watford. The service was inaugurated April 16, 1917, and the through traffic is developing satisfactorily.

METROPOLITAN DISTRICT RAILWAY CO.—The aggregate gross receipts of the five companies, parties to the common fund agreement of Dec. 21, 1915, from all sources were £6,661,862 17s. 4d., and the aggregate amount retained by the five companies for "revenue liabilities," which include working expenses, prior charges, reserves, and other items, was £6,141,526. Under the terms of the agreement the Company is entitled to 12 per cent. of this fund (£62,440 8s. 6d.), and this sum, plus £20,688 4s. brought forward makes a total of £83,128 12s. 6d., which is available for dividend on the second preference stock and further reserve. The gross receipts of the railway, &c., were £1,122,068, and the expenditure was £697,433, and with miscellaneous receipts (£143,639) the total net income is £568,274. With £20,688 from last year, and deducting interest, rentals and other fixed charges (£345,903), the appropriation to reserve (£35,000), and the dividends on guaranteed and first preference stocks (£124,930), the available balance is £83,129. The interim dividend of 1½ per cent., which was paid on the second preference stock for the half-year ended June 30, 1917, absorbed £22,050, leaving £61,079 available, which will admit of the payment of a dividend of 1½ per cent. for the half-year ended Dec. 31, making 3 per cent. for the year, as in 1916. It is proposed to appropriate a further £10,000 to reserve, making a total of £45,000 for the year, and to carry forward £29,029. The capital expenditure during the year amounted to £2,828.

METROPOLITAN RAILWAY CO.—Lord Aberconway who presided over the meeting last week, said the past year had been one of great difficulties for railway companies. Government control prevented them from reaping any benefit from the largely increased traffic, and there had been a heavy additional expenditure due to increased war wages, &c. All new works and improvements had been suspended. Having regard to the frequency of the train service on the various sections of the line, it was absolutely necessary to keep the permanent way, rolling stock, and electrical appliances in a high state of efficiency. To do this under present circumstances, when materials of all kinds, especially manufactured metals, were most difficult to obtain, and when skilled labour was very scarce, had been no easy task. [illegible] year about eight million more passengers than in 1916, [illegible] about 10 per cent., and the [illegible] traffic [illegible] had been impossible to [illegible] and very difficult to cope with. He could not say what would be the position of the railways after the war. Government control in its present form would continue for some time after actual hostilities had ceased, and during the process of demobilisation.

SMITHFIELD MARKETS ELECTRIC SUPPLY CO. (LTD.).—The gross profit for 1917 was [illegible]

SOUTH LONDON ELECTRIC SUPPLY CORPN. (LTD.).—The directors have declared, [illegible]

SOUTH METROPOLITAN ELECTRIC LIGHT & POWER CO. (LTD.).—The revenue account for 1917 [illegible]

In August last the second 5,000 kw. turbo-alternator was put to work. The revenue of the West Kent Co. again shows a satisfactory improvement, the gross revenue having increased from £27,677 to £45,139, and the net revenue from £5,432 to £7,012. Mr. H. B. [illegible] has recently been appointed a director of the company.

WESTMINSTER ELECTRIC SUPPLY CORPN. (LTD.).—The directors' report states that the total power of the lamps, motors and apparatus connected to the mains, which on Dec. 31, 1916, was the equivalent of about 43,969 kw., had increased by Dec. 31, 1917, to the equivalent of about 48,084 kw. An interim dividend at rate of 8 per cent. per annum on the ordinary shares and the dividend on the 4½ per cent. preference shares, for the half-year ended June 30, 1917, have been distributed. After allowing for depreciation, sinking fund and other charges, the balance is £53,142, from which must be deducted the second half-year's dividend on the preference shares (£12,375), leaving £40,767. Out of this the board recommend payment of a dividend at the rate of 10 per cent. per annum (less tax) for the past half-year, making 9 per cent. for the year, carrying forward £13,267. 2s. 2d.

YORKSHIRE ELECTRIC POWER CO.—At the annual meeting on Tuesday, the chairman (Mr. A. G. Lupton) said that the directors could fairly claim that the progress made in the past year had been satisfactory, showing as it did an increase of revenue at the rate of 25 per cent.; but he proposed to speak of the progress made during the last 12 years and the position to which it had now attained. The company was formed for supplying electricity throughout the industrial area of the West Riding in the belief that a cheap power supply was essential to the industrial prosperity of the county, and that its development would bring other incidental advantages in the shape of new industries to the district. To-day it was generally realised that the supply of electricity on tap through large areas from central stations was vital to the industries of the country; but when in 1900 a number of business men and engineers met together and decided to take that in hand they were pioneers so far as the West Riding of Yorkshire was concerned. The revenue for the first full year of operation amounted to £915. To establish a new industry, and especially one on the scale of theirs, must necessarily take time, but it was perhaps fortunate that they did not realise how long a road they were entering upon; if they had appreciated the labour it would entail he thought they might have hesitated to undertake such a task. The first generating units installed were three turbines, each of 1,500 kw., together 4,500 kw. Each year their business increased, larger units had been installed as required, and to-day they had running on load a turbine of 6,000 kw. [illegible] and in the course of a few weeks they should have 26,000 kw. running at the Thornhill and Barugh stations, in addition to the 4,500 kw. plant from which they obtained current to supply the eastern portion of their area, and which they hoped before very long to see connected up to their general system of mains. They had laid down 358 miles of mains, running over a considerable part of their area. They were planned according to a comprehensive scheme in view of the extensions which were steadily being carried out. Already they [illegible] and they had 120 sub-stations or distributing stations. The capital on which they went to issue was £198,000. Including loans on mortgage [illegible] capital of the Yorkshire Waste Heat and the Electrical Distribution of Yorkshire Companies, [illegible] the revenue of the Power Company for the year 1917 amounted to [illegible] In September, 1916, [illegible] that had been absorbed, and applications for the remainder continued to be received. [illegible]

stations as would be needed for the future should be outside the large towns and in proximity to the coal fields, and they must, to obtain the full efficiency of the modern steam turbine, be adjacent to an ample supply of water. The West Riding was well supplied with streams, though individually on a rather small scale compared to the requirements of modern central generating stations, so that the directors had felt it necessary to look ahead. They had arranged to acquire a site and erect a station at Ferrybridge, where the water supply and the proximity to the coal fields would enable large generating units to be installed and worked under the most economical conditions. During the war they had been called upon to supply power to various works, and had been able to give them valuable assistance in the saving of time as well as money, and owing to their supply the country had made a clear saving of the consumption of 50,000 tons of coal. The treatment of coal so as to extract its valuable chemical constituents, as well as to use it for power, was a problem which was engaging the attention of the Government, the coal and chemical trades and others, and in that new development the company was actively assisting. The problem was such an important one that all the interests involved should work together, each taking its part, and the company looked for a further development of the co-operation with colliery owners, of which an instance was found in the utilisation of coke-oven gas at their Barugh power station. The company's area of supply included the great Yorkshire coal field, with an annual output of some 40 million tons, and in which 400 mines were worked. The collieries were already important users of the company's supply to the extent of over one-third of the total output, and the growing appreciation of the advantages of co-[illegible] collieries and the company should lead to a large increase of that business. Great developments were also taking place in the iron and steel industries, and preparations were being made for the time when peace might be restored. These developments would provide a demand for every unit of electricity that they could generate, and their company must be prepared to take its part with a full hand when the time came. The country had realised that the supply of electricity from large central stations is vital to the national industries. They had no doubt seen the report of the Coal Conservation Sub-Committee of the Ministry of Reconstruction, and the Board of Trade Electric Power Supply Committee was now sitting to consider how the desired results could be best attained. One solution of the problem would be co-operation between the installations of the large municipalities in their area and their company, that the smaller stations should be gradually closed down and that they should take their supplies from a few large installations, which [illegible] on the most scientific basis for economy of coal consumption and the reclamation of by-products. They had tried to obtain co-operation in that direction and should welcome it. With every extension of output on such a plan there should come reduction of cost in the production of electricity, to the benefit of all concerned. Already, he was glad to say, they were working in concert with the City of Bradford under an agreement. They hoped to extend that agreement to [illegible] endeavouring to enter into similar working arrangements with other cities. These new departures would [illegible] on the part of their company. Plans and [illegible] were being prepared, and when they [illegible] they would be asked to sanction the further issue of capital. [illegible] would have before it the task of reconstruction, its industries [illegible]

City Notes.

[illegible]

MATHER & PLATT (LTD.)—The net profit for the year 1917 was £168,487 (against £171,053 in 1916) and £86,514 was brought forward. A final dividend of 12½ per cent. is proposed on the ordinary shares, making 17½ per cent. for the year, adding £35,000 to the income-tax, equalisation fund and carrying forward £95,001.

GLOBE TELEGRAPH AND TRUST CO.—A dividend of 2s. per share (tax free) has been declared on the ordinary shares for the quarter, payable 26th proximo.

GUERNSEY RAILWAY CO—The net profit for the year 1917 (including £454 brought forward), after writing off £807 for depreciation, placing £200 to reserve and £600 to permanent-way renewals reserve, &c., amounts to £1,576. A dividend of 5 per cent. per annum has been declared on the ordinary shares, leaving £319 to be carried forward.

HONG KONG TRAMWAYS CO. (LTD.)—A dividend of 14 per cent. (less tax) making 23 per cent. for the past year, has been declared and £42,267 has been carried forward.

The Round Table.

By "kVA."

I think the following menu card, used by the South African Institute of Electrical Engineers at the only solid dinner of the session which the members have sat down to, will be read with interest in these days of rationing at home:—

DETAILED SPECIFICATION.

PRELIMINARY.

Receivers of the plant are entitled to receive ample supply of Lubrication.

No responsibility for the performance of the plant will be accepted unless the matter is reported.

Advice will be given gratis by the supplier's experts on the subject.

WAR CONDITIONS CLAUSE.

Owing to the difficulties in obtaining supplies, items are subject to variation without notice.

Name of Item	MAIN PLANT.	REMARKS.
Hors d'ouvres	To be of the usual English pattern, modified where necessary to suit South African conditions.	
Fish.	Guaranteed 1917 model, supplied immersed in high-class insulating liquid of s.p.g. not less than ·9827764.	Light Lubrication to be commenced here.
Soup.	Receivers have the choice of two viscosities (measured by the well-known B.P. method.)	
Entree.	Asparagus (delivered at the absolute zero or thereabouts) of the automatic type, no tools being required for taking to pieces.	Lubrication should be forced if necessary here.
Joints.	Our own patent for insertion only. To be of the universal type, being equally suitable for the largest pipes or the smallest electric wires. (Power Station Superintendents grow fat on it.)	
Poultry.	New S.A. Standard type. Material used is to be of low tensile strength, mounted on substantial frame; wings and legs provided in duplicate but not interchangeable.* Supplied packed with S.A.G.E. composition. Blow down valve not included. (*Interchangeability is in course of development, and experiments are being conducted.)	
Sweets.	To be manufactured to the specification of two eminent sugar refinery engineers. Can also be supplied in High Pressure steel drums under the [illegible] name Mural, and labelled "Dangerous" in large red letters.	All Lubrication to be well charged here.
	AUXILIARY PLANT.	
Cheese.	To be of the low voltage type, but [illegible] high pressure type can be [illegible] on request [illegible] normally kept in our own primary cells.)	
Coffee.	Guaranteed non-sludging and good conductivity.	[illegible] may be set away
Ices.	[illegible]	
Cigars.	[illegible]	

[illegible]

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

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CONTENTS.

Notes.

The Coal Conservation Report.

In our correspondence columns we publish a letter by Mr. F. W. Purse, city electrical engineer of Carlisle, criticising the report on Electric Power Supply which was issued recently by the Reconstruction Committee. We are glad to publish this letter, because we feel that it is an advantage to have such far-reaching proposals discussed from every point of view. At the same time, we doubt if it is any use going into minor details. The report deals with general principles, and we think it is best to discuss such questions broadly, leaving details to be decided at some later stage. From the point of view of municipalities the report is open to attack, because the Committee included no municipal representatives among its members. On the other hand, the conclusions of the Committee have been very largely endorsed by leading municipal engineers. The main question is whether we are to be content with generation on a small scale, which is obviously inefficient [illegible] with linking up in various districts), or whether we are to have [illegible] the smaller stations being converted into sub-stations. Per- [illegible] tricity supply in this country afresh. We do not think there [illegible] cheap energy were expected from the smaller undertakings in [illegible] lower than if the area is supplied by a number of smaller stations. It may be that Lancashire would not be able to absorb quite as large a proportion of power as [illegible] the north-east coast. The fact remains, however, that the comparison is fair enough as demonstrating the view that the [illegible] been considerably cheaper if the supply over the whole area had been in the hands of one authority.

Municipal *v.* Private Enterprise.

Mr. Purse also seems to think that the municipal authorities have been hampered quite as much as the companies. We cannot agree with this view. Municipalities have been somewhat restricted by their statutory powers, but there has been no great outcry against lack of powers until the last few years, and dissatisfaction has been chiefly in regard to powers of hiring. On the other hand, there is no question whatever that private enterprise has been hampered time after time by obstruction on the part of municipalities, and frequently by municipalities playing the part of dog in the manger. It is better, we think, to accept this fact rather than to gloss it over. If municipalities had been correspondingly hampered by private enterprise the case would be very different. Municipal obstruction has very generally been due to a feeling that the prospect was not sufficiently good for municipal enterprise, but might at some time, more or less remote, prove to be a good investment. Consequently, the public interest was disregarded. To some extent this is an inherent defect in the working of local authorities. They cannot take the risks that are taken by private enterprise, and, therefore, municipal progress is necessarily slower. This brings us to one of the main questions, whether the supply should be handled by municipalities or by private enterprise.

"Soullessness."

[illegible] the same characteristic if electricity supply in this country were controlled by private enterprise. Is it not rather more probable that the soullessness would be a characteristic of large municipal control, which necessarily approaches Government control in its characteristics? We confess that if the greatest progress is to be made we feel that there is a very great deal to be said in favour of control by private enterprise, but that private enterprise alone for such a purpose presents some dangers from the public point of view. On the other hand, if private enterprise is controlled in some way or another, [illegible] dividends, like the gas companies, we feel that the greatest [illegible] served. In this connection it is interesting to note the state- [illegible] Municipal Electrical Association. In this statement the [illegible] takings should be acquired by them upon fair and equitable [illegible]

item in this statement to which attention may be called is the view that any changes should take into consideration the effect on the status or remuneration of any officers in electricity undertakings. This we think is a very correct principle, and, provided that this principle is observed, the engineers responsible for the smaller undertakings must be prepared not to stand in the way of national requirements, as distinct from what may be called the pride of the parish.

City and Guilds Examinations.

Little more than a year ago, in commenting on the Report of the work of the Department of Technology, reference was made to the gloomy outlook as regards the technical training and education of the rank and file. A gloomier prospect was predicted for the session just closed, and the Report itself, recently to hand, makes disquieting reading. In the Session 1913-14 there were 55,996 students attending 5,049 registered classes. Of the 23,119 candidates presented for examination, 14,570 satisfied the examiners. Reduced to a percentage basis, 41·3 per cent. of the registered students sat for the examinations and of these, 63 per cent. (or 26 per cent. of the total students in attendance) passed. In the Session 1916-17, the number of students had dropped to 29,062, the number of registered classes to 2,752, and of 7,508 candidates examined, 4,514 passed. Thus, in 1916-17, 25·8 per cent. of the registered students were examined and 60 per cent. (or 15·5 per cent. of the registered students) passed. In the Report it is stated that the regulations under which all lads . . . were called up on attaining the age of 18 years for home defence were not in force at the opening of the session, but have since had a drastic effect on the attendances at registered classes and on the number of candidates for examinations. The remunerative employment that youths can now command as soon as they have left the elementary school has no doubt rendered many disinclined to continue their attendances at evening classes in technical schools. Further, overtime is becoming chronic in many industries. This overtime accounts for a good deal of the percentage reduction of the registered students examined in 1916-17. For these reasons the figures given above for the numbers of classes and students do not show the full extent to which attendance at evening classes has fallen off. The full extent will, however, be apparent, even to the education authority, in another 12 months. It is satisfactory to note that [illegible] in the [illegible] of the examinations of the Institute, which will be continued on the same lines as heretofore. Many will be interested to hear that the policy of [illegible] for class and home work to count to a certain extent in the examinations is under the consideration of the Technology Committee with a view to its [illegible] [illegible] From [illegible] [illegible] student [illegible] the West [illegible]

[illegible] Association.—[illegible]

Allen West Engineering Society.—Last week the staff of Messrs. Allen West and Co. had the advantage of hearing a Paper by Mr. F. G. Smith, joint managing director of Messrs. Wellman, Seaver and Head, on "Steel Works Charging Machinery." This was followed by an interesting discussion.

Institute of Metals.—The annual general meeting of the Institute of Metals will be held on March 13 and 14 in the rooms of the Chemical Society, Burlington House, London. On the 13th the president-elect, Prof. H. C. H. Carpenter, will take the chair and deliver his presidential address. On the 14th a selection of Papers will be read.

Power Supply on the North-East Coast.—We have received a pamphlet by A. Gemmell criticising severely the financial arrangements made between the various companies interested in power supply on the North-East Coast. Our readers will remember that Mr. Gemmell has been a critic in this direction for some years.

Junior Institution of Engineers.—At a recent meeting of the Junior Institution of Engineers held at Newcastle-on-Tyne, a resolution was moved by Mr. M. Ward and seconded by Mr. W. Thornton, that permission be asked from headquarters to form a local section of the Institution at Newcastle-on-Tyne. The chairman (Mr. W. A. Tookey) pointed out the educational advantages of the proposal, which was also supported by Mr. G. S. Lisle and carried.

Incorporated Municipal Electrical Association.—The annual meeting of this Association will be held this year at Manchester on Thursday, June 20, and Friday, June 21. On the Thursday Mr. S. J. Watson will deliver his presidential address, and there will be a discussion on "The Future of Electric Power Supply." During the afternoon of that day visits will be arranged to works in Manchester, including the works of the British Westinghouse Co. and the Stuart-street power station of the Manchester Corporation. On the Friday the discussion on "Electric Power Supply" will be resumed, and the annual general meeting will be held.

"Journal" of the Leeds University Textile Association. The issue of the "Journal" of the Leeds University Textile Association for January contains a number of readable articles, several of which illustrate the bearing of physics on processes in the textile industry. Mr. W. Harrison writes on the "Measurement of Temperature in Textile Processes," and Mr. A. F. Barker on "Converse Straight Fibre and Concurrent Twists in Botany Worstings," while Mr. Walter Low deals generally with "Factory Organisation." At the end of the "Journal" are articles on "Woollen Spinning and Woollen Machinery."

The Photo-Electric Action of X-Rays.—In a Paper before the Royal Society on Feb. 7, Prof. O. W. Richardson discusses the excitation of electron emission by X-rays, in relation to our knowledge of the photoelectric action of other types of radiation. The main conclusions are the following: A formula was presented expressing the ratio E_K/E_λ of the energy E_K emitted in the form of K secondary X radiation to the energy E_λ of the primary radiation (wave-length λ) in the case of bromine. The formula implies the emission of one electron for every quantum ($h\nu$) of primary radiation absorbed. The facts under consideration support the hypothesis that the primary radiation is absorbed in the whole quanta.

Ramsay Science Fellowships.—The Ramsay Memorial Fund which aims at raising not less than £100,000 as a tribute to the memory of the late Sir William Ramsay, has two important scientific objects, namely, the foundation of Ramsay Memorial Fellowships in chemical science and the establishment of a laboratory of engineering chemistry in University College, London. The appeal on behalf of the fund has been before the public for about nine months, and more than £[illegible] has been collected. The scheme is contained in two memoranda signed by Mr. Asquith as president of the fund, by Mr. H. A. L. Fisher as one of the vice-presidents, and by Lord Rayleigh as chairman of the General Committee. The object is to provide Ramsay Memorial Fellowships of the value of £[illegible] a year with an expenses grant of £50 a year.

Mineral Resources of South Africa.—A Paper recently read before the Royal Society of Arts by Mr. C. du Plessis Chiappini, Trade Commissioner for the Union of South Africa, gives a very full account of the industrial resources of that country. Special interest attaches to the mining industry. The total value of the mineral output of the Union in 1916 amounted to £50,593,000, and the mines employ nearly 316,000 people. The total capital invested in the gold mines, practically all of which are in the Transvaal, is £82,373,000, and South Africa contributes annually about 41 per cent. of the world's output in gold. It is not surprising that this industry offers an exceptionally good field for electrical development, and the growth of the large electric power concerns which have been developed in South Africa will no doubt be assisted by the continued prosperity of the mining industry.

Institute of Chemistry.—The report of the Council of the Institute for 1917–1918, states that the Register now contains the names of 1,356 Fellows and 491 Associates—an increase during the year of 355 members. The names are mentioned of 15 members who have died on active service. The president (Sir James Dobbie) and Sir Herbert Jackson have been reappointed for the year 1918, as representatives on the Board of Scientific Societies. Dr. Harden is representing the Institute on the Standing Committee of Professors' [illegible] in connection with the scheme of the Board of Education for the better organisation of examinations in secondary schools. Reference is also made to the further investigations undertaken by the Glass Research Committee [illegible] to testing laboratory glassware and porcelain. A scheme of regulations has been adopted for the admission of [illegible] which is set out in detail, and the report of the General Purposes Committee on Professional Organisations is published *in extenso*.

The Metric System for the British Empire.—A Paper on the above subject was read before the Institution of Post Office Engineers by Mr. A. J. Stubbs on Jan. 22. After explaining the basis of the metric system Mr. Stubbs gave a summary of its advantages from the scientific standpoint, for the simplification of calculations, and as an assistance to British foreign trade. Dealing with the objections that have been raised to the change, the author quoted the remarks made on this point in his recent Paper before the Institution of Electrical Engineers, and explained how by the dual system the period of transition could be rendered more easy. As an example of how British and metric measures might for a time be continued side by side, a table was presented showing the lengths of poles for aerial lines expressed in both ways. A final section of the Paper dealt with the important question of Imperial coinage, the author remarking that internationalisation of coinage was not desirable, but that there was much to be said for uniformity of coinage throughout the British Empire.

The Wild-Barfield Furnace for Alternating Current Working.—It will be recalled that some time ago we gave an account of the Wild-Barfield furnace,* and its application to the hardening of steel gauges. The essential principle of the furnace is [illegible] temperature steel becomes non-magnetic. The furnace then described was suitable for direct current. We have now had an opportunity of inspecting at the Westminster Electrical Testing Laboratory a furnace in which the same principle can be applied with alternating currents and which therefore renders unnecessary the cost of motor-generators.

[illegible]

[illegible]

* The Electrician, Vol. LXXIX., p. [illegible]

ment, which takes the form of a vibration galvanometer, or ordinary moving-coil instrument can be used for the purpose.

Before any steel article is [illegible] into the furnace the voltages induced in the two secondary coils balance exactly, and the galvanometer receives no current, and its "spot" remains perfectly steady. As soon, however, as a steel article is placed in the furnace the steel is magnetised by the heating winding, the total amount of magnetism passing through the secondary winding is increased, the secondary voltage also is increased, balance between this and the secondary voltage of the auxiliary induction coil is destroyed, and an alternating current is circulated through the indicating instrument, which is indicated by the spot vibrating and its image becoming blurred.

As soon as the steel arrives at the temperature of decalescence it also becomes non-magnetic, the original conditions are restored to what they were before the steel was introduced into the furnace, and the "spot" immediately stops vibrating.

It is thus known that the steel has arrived at the true decalescent temperature, and if it is withdrawn and quenched at once it will be properly hardened without being over heated, a condition necessary for all cutting tools of the finest [illegible].

Personal.

Dr. R. S. Willows, head of the department of physics and mathematics at the Sir John Cass Technical Institute, has been appointed principal physicist to Messrs. Tootal Broadhurst Lee & Co., of Manchester.

Mr. R. S. Pilcher, manager of Aberdeen Corporation tramways, has been appointed [illegible] secretary of the Northern Scottish area of the National Tramway Committee, including the Dundee, Broughty Ferry, Perth, Stirling, Kirkcaldy, Aberdeen City and Aberdeen suburban tramway systems.

Mr. E. Kilburn Scott, A.M.I.C.E., M.I.E.E., has been appointed consulting engineer to the British-American Nitrates Co. of New York.

Mr. Scott, who left England in January to deal with the exploitation of his patents for manufacturing nitrates electrically, will be in America for some time. His present address is: C/o The British-American Nitrates Co., 299, Broadway, New York.

Arrangements for the Week.

FRIDAY, March 1st (to-day).

ROYAL INSTITUTION.

5.30 p.m. At Albemarle-street, Piccadilly, London, W.1. Discourse on "The Modern Dye Stuff Industry," by Prof. A. G. Green, F.R.S.

SATURDAY, March 2nd.

ROYAL INSTITUTION.

3 p.m. At Albemarle-street, Piccadilly, London, W.1. Lecture on "Problems in Atomic Structure," by Prof. Sir J. J. Thomson, P.R.S. (Lecture III.)

LONDON ASSOCIATION OF FOREMEN ENGINEERS.

7 p.m. At Cannon-street Hotel, London, E.C. Paper on "Painting and Wood Finishing from the Engineer's Standpoint," by Mr. A. S. Jennings.

MONDAY, March 4th.

ROYAL SOCIETY OF ARTS.

4.30 p.m. At John-street, Adelphi, London, W.C. Cantor Lecture on "The Economic Condition of the United Kingdom before the War, the Results of the War and [illegible]," by Mr. E. Crammond. (Lecture III.)

TUESDAY, March 5th.

ROYAL INSTITUTION.

3 p.m. At Albemarle-street, Piccadilly, London, W.1. Lecture on [illegible] (Lecture II.)

WEDNESDAY, March 6th.

[illegible]

THURSDAY, March 7th.

[illegible]

FRIDAY, March 8th.

[illegible]

The New Split-Phase Locomotive of the Pennsylvania Railroad: Control Equipment.*

By A. J. HALL.

Split-phase locomotives utilise single-phase energy from an overhead trolley which is transformed into three-phase energy through the medium of a rotating type of phase converter to supply power to three-phase induction motors. A typical example of this type of locomotive is that recently built by the Pennsylvania Railroad. In this locomotive, single-phase current at 11,000 volts is collected by a pantograph trolley, first passing through an oil circuit breaker to the primary of a transformer, from which connection is made to the locomotive frame. The return circuit is completed through the rails to the sub-station.

The secondary of the transformer supplies power to the phase converter, which is really a motor-generator producing a supply of power with a voltage displacement of 90 deg. from the transformer secondary voltage. This two-phase source of supply is then transformed into three-phase energy by means of the two-phase, three-phase Scott connection. Fig. 1 shows the main circuit connections. connecting the phase converter from the secondary of the transformer, or short-circuiting the transformer coils.

Three-phase power is supplied to each of the four motors through a set of five electropneumatically operated unit switches. These motor primary switches are also used as reversing switches. One of the switches is used commonly for both forward and reverse operation; and the other four switches are used in pairs to interchange the connections of two of the phases in order to produce forward or reverse rotation of the motors. The motors are arranged for two-speed combinations, corresponding to approximately 10 and 20 miles per hour. Each pair is connected in cascade on the low speed, the secondary of one motor being connected to the primary of the other, while the secondary of the latter is connected to an adjustable liquid rheostat for speed regulating purposes. The motor primaries are connected to the three-phase supply in parallel on the high speed, each secondary being connected to a regulating liquid rheostat.

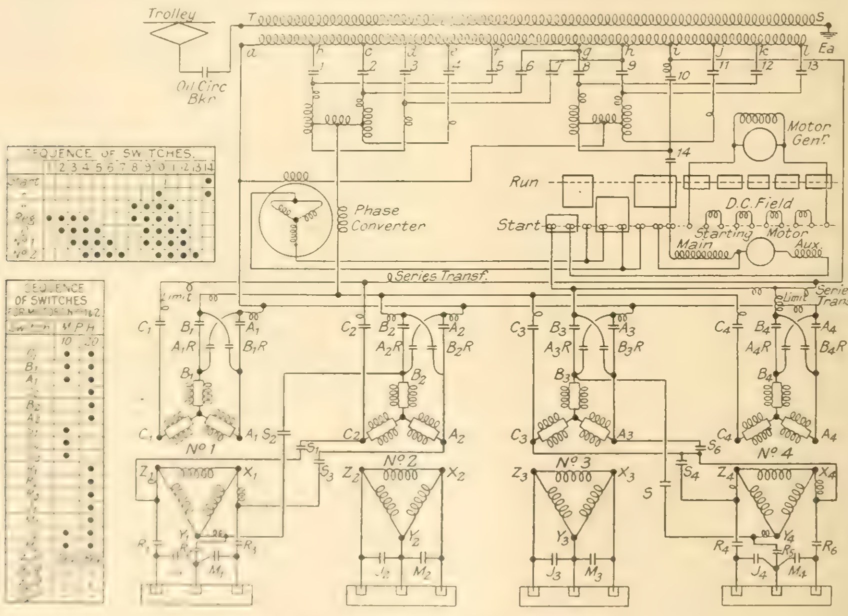

Fig. 1.—Schematic Diagram of Main Connections.

[illegible]

[illegible]

The control is arranged so that the change from one speed to another is made without losing more than half of the accelerating or regenerating torque, this result being accomplished by effecting an alternate transition of the pairs of motors.

The four liquid rheostats required to govern the driving motors are housed in two separate tanks, the casings of which are built as a part of the locomotive frame. Each tank contains two sets of electrodes (Fig. 2). Centrifugal pumps circulate liquid continuously through each of the tanks. The level of the liquid in each tank can be varied independently by means of tubular overflow valves, which are controlled by differential air engines.

The maximum voltage across the electrodes of these rheostats ranges from 800 to 1,000 volts, whereby a heavy accelerating current is obtained with a great economy in space and weight. This is the highest voltage that has ever been applied to a rheostat of this type, which is made possible by the use of staggered insulating barriers located in the bottom of the tanks, which increase the resistance between adjacent electrodes by causing the current to follow tortuous paths in passing through the electrolyte.

The liquid rheostats are located in the centre of the locomotive, one pair on each side of a cooling tower compartment containing

* [illegible]

two cooling towers, Fig. 3. A small percentage of the liquid is by-passed to the top of the cooling towers and flows over the surface of the cooling tower trays back into the main tank. At the same time, air is blown over the trays in a direction opposite to that of the flow of the liquid. In this way the body of the electrolyte in the main supply tank is sufficiently cooled by the expenditure of a relatively small amount of pumping energy and by the sacrifice of a small amount of electrolyte lost by evaporation. A common main supply tank for all the rheostats is located under the electrode-containing and cooling-tower compartments, being built in as a part of the locomotive framework. This arrangement is very compact and insures the same liquid density and temperature for all rheostats.

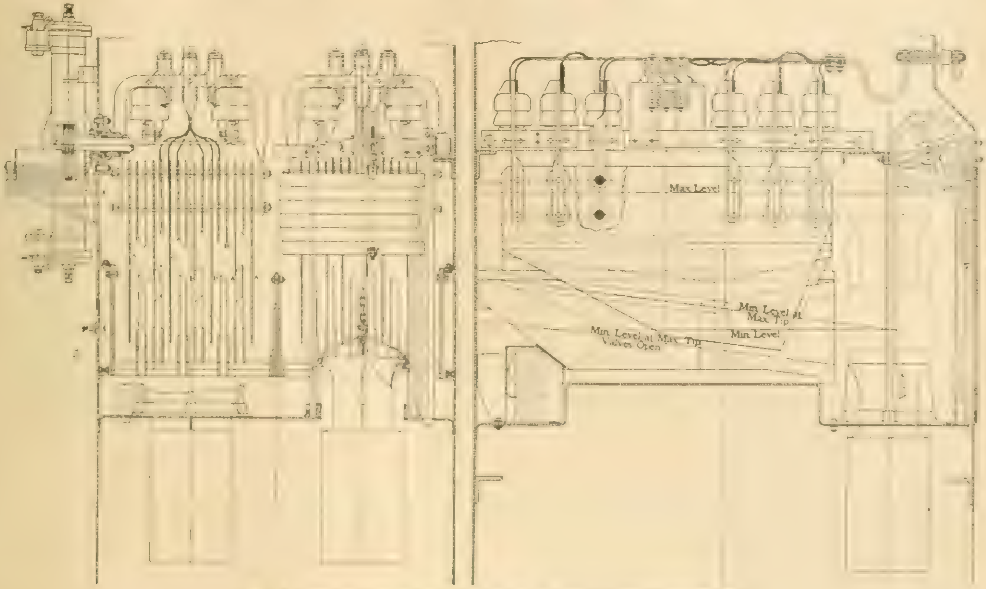

FIG. 2.—FRONT AND SIDE ELEVATIONS OF THE LIQUID RHEOSTATS.

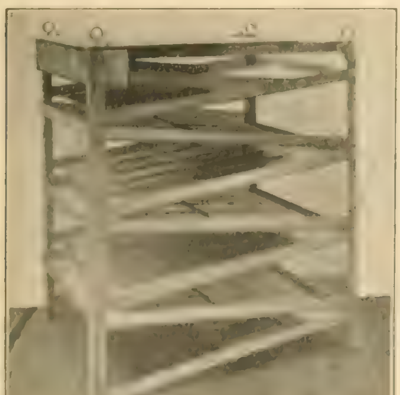

Fig. 3.—[illegible]

Fig. 4.—[illegible]

In operation it has been found that [illegible] increases rapidly [illegible] which gives protection to the locomotive [illegible] when starting a heavy train.

The circulating pumps draw the liquid from the main tank and force it into the electrode compartments through [illegible] which prevents any splashing and insures the equalisation of level over the entire width of the tank. When the liquid level has reached its maximum height, which occurs when the overflow valves occupy their uppermost positions, a set of switches is automatically closed to short-circuit the secondary motor winding and cut out the liquid rheostats.

Induction type three-phase motors are used to operate the blowers and electrolyte pumps for the liquid rheostats. A low voltage three-phase circuit is obtained for starting these motors by taking the middle tap out of each leg of the Scott connection. A pneumatically operated cam type auto-starter is used to change over from the low starting voltage to the higher running voltage. The control which operates this switch is such that the auxiliary motors cannot be started until the phase converter is operating; but the motors, [illegible] after the phase converter has been shut down [illegible] the [illegible] of the [illegible].

The operation of the locomotive is normally controlled by a master controller, Fig. 4. One of these master controllers is located in each of the operating compartments. These handles are provided [illegible], speed and acceleration.

The Reverse Handle is used for changing the direction of movement of the locomotive by closing the proper set of primary switches.

The Speed Handle is employed to change over the speed combination of the main motors from cascade to parallel operation. It has

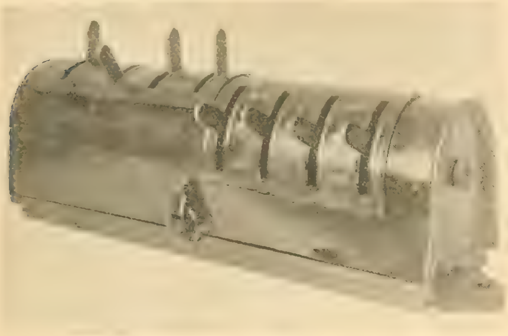

FIG. 5.—AUXILIARY MASTER CONTROLLER.

three positions, one each for the 10 and 20 mile per hour combinations, and one midway between these two, which is used as a transition position to enable one pair of motors to be changed over to [illegible].

The Acceleration Handle is utilised to control the primary switches and the differential air engine which varies the level of the liquid in the rheostats. It has three positions marked *raise*, *hold*, and *lower*. These words refer to the level of the liquid in the rheostat by which the speed of the locomotive, during either cascade or parallel motor connections, is varied. A movement of the handle to the *raise* position and then back to the *hold* position will give a positive increment in rise of the liquid level, and a movement of the handle to the *lower* and then back to the *hold* position will lower the level of the liquid in the liquid rheostats.

Overload protection is obtained by a current limit relay, a means of protection which has the advantage that it will not open the circuit, but will first arrest the rise of the liquid level in the rheostats, and will then lower this level if the accelerating current goes beyond a certain fixed maximum value.

The liquid rheostats may be operated independently of each other by means of levers located in an auxiliary master controller, Fig. 5, which is used for equalising the load on the different pairs of motors and to reduce the current supplied to one pair of driving motors when they slip, without affecting the other pair. The auxiliary master controller also has levers which will raise and lower the trolley, start and cut out the phase converter, and operate the phase converter voltage and phase-balancing switches.

Regenerative braking does not require any extra control equipment. This is due to the inherent characteristics of the induction motor. The manipulation of the master controller is exactly the same for regeneration as it is for running.

The control of this type of locomotive is extremely simple for both running and regenerating, requiring no special knowledge other than that of the manipulation of the air brakes when handling heavy trains.

Electric Power Supply.

As we stated in our last issue, a statement has been prepared by the Incorporated Municipal Electrical Association in conjunction with the Association of Municipal Corporations in regard to the supply of electric power.

This statement (which has been submitted to the Board of Trade Electric Power Supply Committee) is as follows:

1. To ensure that there shall be an adequate and economical supply of electric power it is necessary that the areas of supply, instead of being local government areas, should be areas specially delimited as areas suitable for electric supply, having regard to demand and facilities for obtaining suitable sites for generating stations. The application of this principle must depend upon the local circumstances, including the position of existing supplying and distributing authorities, and the facilities possessed by them and their liabilities and obligations.

2. Different considerations will apply to generation and distribution, and these need not in all cases be in the same hands. Generation should be on a large scale and extend over a considerable area. Distribution, which entails dealing with individual consumers, may conveniently be organised in smaller areas.

3. The new areas, both for generation and distribution, should be continuous, and will in many cases include within their limits places which at present are without a supply, either because no powers exist there or because existing powers have not been exercised.

4. [illegible] of an adequate and [illegible] should be made of existing [illegible] and also of the [illegible]

The [illegible] to be [illegible] to the circumstances.

5. [illegible]

6. [illegible] source of supply, the object would be attained by facilitating an extension of the large area for the purpose of the generation and transmission of energy, so as to include the small areas and by transferring to the large undertakings upon fair terms the generation and transmission systems of the small undertakings. The distribution including the areas now without supply would be carried out locally either by the existing authorities or by the large authority. The remarks as to distribution areas in paragraph 5 would also apply in this case. (*b*) A new authority might be established similar to that outlined in paragraph 5 to carry out the generation, transmission and distribution of electrical energy throughout a large area acquiring on fair terms all the existing interests within such areas.

7. When the whole or a portion of an existing undertaking is transferred to a larger authority, suitable provision would be made in regard to the rights and obligations of existing undertakings, the capital commitments and the responsibilities towards any officers whose status or remuneration would be affected.

8. In our opinion it would be a fatal mistake to depart from the principle upon which Parliament has acted with very few exceptions for many years past, that undertakings of this description, which involve a monoply and upon which the prosperity of the people depends so largely, should be entirely in the hands of the public authorities.

9. These proposals would be complicated in districts which are now partly supplied by companies. With the exception, however, of London, and of an area to the north-east coast of England, there are very few places where undertakings of any size are vested in companies, and probably where there are such undertakings the best course would be for the joint board or the extended municipal undertaking referred to in paragraph 3 to acquire them upon fair and equitable terms.

10. The questions of London and the north-east coast require special consideration, and the foregoing observations are not intended to apply to them.

11. We have also considered the question of a central Government authority, and whatever may be the ultimate form or constitution of the authority, we think that in view of the many important decisions to be made in the immediate future and the new duties and powers which will fall to be administered, it should be strong on the technical and [illegible] side. We consider also that whatever central authority is entrusted with such work, it must be responsible to Parliament.

Books Received.

[illegible] can be had from THE ELECTRICIAN Offices, on [illegible] postage.

"Theory and Operation of Direct Current Machinery," by Cyril M. Jansky, B.S., B.A. (London: The Hill Publishing Co.) Pp. x + 283. 10s. 6d.

"British Engineers' Association Directory of Members," 1917. (London: British Engineers' Association.) 5s.

Notes on the Design of Electromagnetic Machines.*

PART III.

DESIGN OF AN ALTERNATING-CURRENT TURBO-GENERATOR.

By STANLEY PARKER SMITH, D.Sc.

(Continued from page 705.)

Summary.—In Part I. of the article the author deals with some of the main principles underlying the design of alternating-current generators. In Part II. these principles are applied to the design of a low-speed, three-phase alternator, giving 750 kw. at 2,200 volts when running at a speed of 250 revs. per min. In Part III. a three-phase turbo-alternator is designed to give 2,000 kw. at 3,000 revs. per min. at a line pressure of 500 volts, and the mechanical stresses in the rotor are discussed.

5. HEATING CALCULATIONS.

Having settled the dimensions of the machine, we must now proceed to see whether the design will meet the specified duty.

The electrical losses have already been calculated, and the mechanical losses must also be estimated before the temperature rise can be predicted.

The mechanical losses heating the cooling air passing through the machine are the windage and fan losses, the bearing loss being carried off by the oil pumped through the bearings.

(*a*) *Windage Loss.*—In axially-ventilated machines, where only a part of the air passes through the gap, this loss is considerably smaller than in machines where all the air has to go along the gap. Owing to the absence of reliable data, however, it is not possible to calculate this loss with anything like the same degree of accuracy as, say, a resistance loss. We shall assume the windage loss to be :—

0·5 watt per cm.[2] of the cylindrical surface of the rotor.

0·8 watt per cm.[2] of the cylindrical surface of the end-bells.

Cylindrical surface of rotor : $\pi 61 \times 100 = 19{,}000$ cm^2.

Cylindrical surface of 2 bells : $2\pi 63 \times 26 = 10{,}300$ cm^2.

Whence we have :—

Windage loss on rotor surface $= 0{\cdot}5 \times 19{,}000 = 9{\cdot}5$ kw.

Windage loss on end bells $= 0{\cdot}8 \times 10{,}300 = 8{\cdot}2$ kw.

(*b*) *Fan Loss.*—This loss can be calculated much more closely if the fan efficiency and the delivery and head are known.

The power needed to raise a given volume of air per second to a specific pressure (or head) can be found as follows :—

Power = total pressure × velocity

= (specific pressure × area) [illegible]

= specific pressure × volume per second,

or $P = p$ [illegible]

[illegible]

[illegible]

the head of water measured by the water gauge in cm., whilst V [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

* [illegible]

head and resistance to air flow, which are really the limiting factors. In an axially-ventilated machine of the present type and peripheral speed, we can assume a 6 in. head and a mean axial velocity of the air through the machine of 20 metres per second.

We thus calculate the volume of air and fan loss to be as follows :—

	Stator fan.	Rotor fan.
Cross-section of channels in cm.[2]	144 holes—2,300 36 ducts— 200 air-gap— 400	16 ducts— 82 10 slots—168
Total cross-section in m[2]	0·29	0·025
Mean axial velocity of air in m/sec.*	20·0	20·0
Fan discharge V in m[3]/sec............	5·8	0·5
Head p in cm. of water*..............	15·0	15·0
Fan efficiency : η*.......................	0·3	0·2
Fan loss (0·1 pV/η)	29·0	3·7

(*c*) *Temperature Rise of Cooling Air.*—Knowing the amount of air passing through the machine and the total losses heating this air, we can now find the temperature rise of the cooling air as it passes from inlet to outlet.

The relation between the loss and the volume and temperature rise of the air is as follows :—

Since the mechanical equivalent of heat $= 0{\cdot}24$ calorie per joule, 1 kw. $= 0{\cdot}24 \times 1{,}000 = 240$ calories per second.

Further, since the specific heat of air $= 0{\cdot}237$, 1 calorie raises the temperature of $1 \div 0{\cdot}237 = 4{\cdot}21$ gm. of air 1°C.

Hence 1 kw. raises the temperature of $240 \times 4{\cdot}21$ gm. $=$ 1·01 kg. of air 1°C. in each second ; or of 1·01/t kg. of air t°C. in each second.

It therefore follows that the heat corresponding to P kw. will raise the temperature of 1·01 P/t kg. of air t°C. in each second, so that the weight of cooling air needed to carry off a loss of P kw. with an air temperature rise of t°C. will be 1·01 P/t kg. per second.

Though the cooling depends on the weight of air, it is the volume of the air that concerns us more directly in designing [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

but this factor becomes important when designing machines [illegible]

[illegible]

[illegible]

[illegible]

[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
Windage loss	17·7 ..
[illegible]	[illegible]
[illegible]	[illegible]

The total volume of air passing through the machine in each second: $V=5{\cdot}8+0{\cdot}5=6{\cdot}3\ \text{m}^3$; hence the temperature rise of the cooling air will be

$$t = 0{\cdot}85\,\frac{P}{V} = 0{\cdot}85\,\frac{155{\cdot}7}{6{\cdot}3} = 20{\cdot}8\ °\text{C}.$$

This is quite a reasonable value for turbo-alternators.

It will be noticed that no allowance has been made for cooling by radiation, &c. Though this may often be quite appreciable, it is all to the good, and by ignoring it we increase the safe margin.

We shall now consider the difference of temperature between iron and air, and copper and iron, in order to find the highest temperatures of the several parts.

(*d*) *Temperature Difference Between Iron and Air.*—The chief cooling surfaces of the cores are the ducts and the air-gap, whilst a certain amount of heat is dissipated at the back of the stator core and at other surfaces exposed to the air. The heat got rid of at the gap and duct surfaces can be estimated by means of the formulæ given by Kapp and Miles Walker.

The heat dissipated from the cooling surfaces depends on the temperature difference between the iron and air and on the velocity of the air.

The heat dissipated at the cylindrical surface of the *gap* is

$$P_1 = \frac{1+0{\cdot}1v}{330}\,A_1 t_1 \text{ watts,}$$

where A_1 = cylindrical surface of the air-gap in cm²,
t_1 = temperature difference between iron and air in °C,
v = peripheral speed of rotor in m. per second.

The heat dissipated at the surfaces of the *ducts* is

$P_2 = Kv_2A_2t_2$ watts,

where K = coefficient = 0·0005 to 0·0014,
v_2 = velocity of air in ducts in metres per second,
A_2 = cooling surface of ducts in cm²,
t_2 = temperature difference between iron and air in °C.

Hence, the heat got rid of from gap and duct surfaces will be

$$P = P_1 + P_2 = \frac{1+0{\cdot}1v}{330}\,A_1t_1 + Kv_2A_2t_2 \text{ watts.}$$

Since we are only dealing with average values in the above formulæ, we can assume as a rough approximation that the mean temperature difference between the iron and air is the same at the gap as in the ducts, that is, $t_1 = t_2 = t$, so that

$$t = \frac{P}{\frac{1+0{\cdot}1v}{330}A_1 + Kv_2A_2}\ °\text{C}.$$

By ignoring the other cooling surfaces we make our pre[illegible] than it should be.

(i.) *Stator Iron.*—Applying the above combined formula to the stator, we have

P = iron loss + slot copper loss = [illegible] watts,
A_1 = cylindrical gap surface = [illegible] cm²,
A_2 = surface of 144 [illegible]
[illegible] cm².

Hence the average temperature difference between the [illegible] will be

$$t = [illegible]$$

Thus the gap surface dissipates [illegible]

and the duct surface dissipates [illegible]

It is seen that [illegible] of the heat generated in the stator is dissipated [illegible] ventilation, where air scrubs the edges of the plates, the cooling is very efficient, and for this reason, we give K a fairly high value ($K=0{\cdot}001$).

It will also be noticed that we have estimated the slot copper losss at 6 kw. Most of the stator stray loss occurs in or near the overhang copper, but this is so effectively cooled that it is not likely that heat will flow from the overhang into the slots.

(ii.) *Rotor Iron.*—Coming now to the rotor, we have

P = rotor copper loss = 12·3 kw. = 12,300 watts.
A_1 = cylindrical surface of core + bells = 19,000 + 10,300 = 29,300 cm².
A_2 = surface of 16 ducts + 10 empty slots = 16 × 9·4 × 100 + 10 × 17·6 × 100 = 15,000 + 17,600 = 32,600 cm².

Hence the average temperature difference between the rotor and the cooling air will be

$$t = \frac{12{,}300}{\frac{1+9{\cdot}6}{330}\,29{,}300 + 0{\cdot}001\times20\times32{,}600} = \frac{12{,}300}{940+650}$$

$$= \frac{12{,}300}{1{,}590} = 7{\cdot}8\ °\text{C}.$$

Thus the *cylindrical* surface dissipates $\frac{940}{1{,}590}\,12{\cdot}3 = 7{\cdot}3$ kw.

and the *duct* surface dissipates $\frac{650}{1{,}590}\,12{\cdot}3 = 5{\cdot}0$ kw.

(*e*) *Temperature Difference Between Copper and Iron.*—The amount of heat conducted through the insulation depends on the temperature difference between the copper and iron, and the thickness and thermal conductivity of the insulation. Again making use of one of Walker's expressions, the heat conducted through the insulation is

$$P = \frac{At\lambda}{i} \text{ watts,}$$

where A = area of the conducting surface in cm².,
t = temperature drop across insulation in °C.,
λ = thermal conductivity of insulation in watts per cm³ per 1°C. of temperature difference,
i = thickness of insulation in cm.

For coil insulations made of mica and paper, or of built-up mica, we can take $\lambda=0{\cdot}001-0{\cdot}002$—the former value for hand-wrapped and the latter value for machine-wrapped insulation.

The thermal conductivity of air is much lower than this, and it is not only very important to exclude air from the tube on account of electrostatic action, but also on account of its high resistance to the flow of heat. If the insulation is properly wrapped on the coils, we can take $\lambda=0{\cdot}0015$.

(i.) *Stator Slot Copper.*—Though it is quite possible that heat will flow from the slots to the well-cooled overhang, in a long machine like a turbo-alternator, it is not likely that this will have much effect on the temperature of parts well away from the ends, and for the purpose of calculation it is safe to assume that all the heat generated in the slot copper has to pass through the slot insulation, to be carried off by the air passing along the gap and ducts.

Applying then the above formula, we have

A = mean area of slot insulation = 36 × 100 × 9·8 = 35,300 cm².
P = heat conducted through slot insulation = 6,000 watts
i = distance from copper to iron = (2·2 − 1·7)/2 = 0·25 cm.

Hence the mean temperature difference between copper and iron in the stator will be

$$t = \frac{Pi}{A\lambda} = \frac{6{,}000\times0{\cdot}25}{35{,}300\times0{\cdot}0015} = 28{\cdot}4\ °\text{C}.$$

To find the copper temperature, we shall have to add this to the iron temperature, but the high temperature difference which exists between copper and iron when the insulation is thick, as in high-voltage machines, shows the need for keeping P/A (watts per cm²) small, to keep the temperature of the copper within prescribed limits.

(ii.) *Rotor Copper.*—Coming now to the rotor, part of the copper loss is got rid of by conduction to the bells and part by conduction through the slot insulation. Only a small part is carried off by the inside of the overhang. We shall assume the part conducted to the bells is equal to the heat dissipated at the cylindrical surface of the bells and that the remainder passes through the slot insulation. Since the total heat got rid of at the cylindrical surface is 7,300 watts the loss dissipated at the cylindrical surface of a bell is

$$7{,}300 \times 26/152 = 1{,}250 \text{ watts.}$$

The conducting surface of the mica insulation between the overhang copper and the bell is $\pi 55 \times 22 = 3{,}800 \text{ cm}^2$.

The thickness of the mica between bell and overhang is 0·4 cm., whilst the thermal conductivity can be taken as high as 0·003, since the insulation is almost pure mica.

The average temperature difference between the overhang copper and the steel bells will be then

$$t = \frac{P\,l}{A\,\lambda} = \frac{1{,}250 \times 0{\cdot}4}{3{,}800 \times 0{\cdot}003} = 44^\circ \text{ C.}$$

Since there are two bells, the heat got rid of in this way will be $1{,}250 \times 2 = 2{,}500$ watts, leaving $12{,}300 - 2{,}500 = 9{,}800$ watts to be got rid of through the slot insulation. The heat generated in each overhang is $12{,}300 \times 80/360 = 2{,}750$ watts, so that $2{,}750 - 1{,}250 = 1{,}500$ watts must flow from the overhang into the slots to be dissipated there. Hence we shall expect to find the temperature of the copper in the slots lower than that of the copper in the overhang.

The conducting surface of the rotor slot insulation is $16 \times 23 \times 100 = 37{,}000 \text{ cm}^2$, whilst the thickness of the insulation is 0·15 cm. Hence the mean temperature difference between the slot copper and the rotor body will be

$$t = \frac{P\,l}{A\,\lambda} = \frac{9{,}800 \times 0{\cdot}15}{37{,}000 \times 0{\cdot}0015} = 26{\cdot}5^\circ \text{ C.}$$

Thus the temperature drop from copper to iron is much less in the slots than in the overhang, and this enables heat to flow from the latter to the former. In the present case more than half the heat developed in the overhang is got rid of in this way, according to the above assumption.

(*f*) *Maximum Temperature.*—Though we can estimate the average temperature difference between the copper and the iron and between the iron and the air, we cannot find the highest temperature of the copper by adding the sum of these two temperature differences to the temperature of the air at the outlet, because a considerable amount of heat will flow along the copper and iron from the hot to the cool end of the machine.

For example, if the stator iron is 12·0° C. hotter than the air passing through it, and the copper 28·4° C. hotter than the iron, whilst the temperature rise of the air is 20·8°, the highest temperature rise of the copper in the stator slots should be less than $12{\cdot}0 + 28{\cdot}4 + 20{\cdot}8 = 61{\cdot}2^\circ$ C. owing to the flow of heat towards the cool end of the machine. Nevertheless, this is sufficient to show that the rise permitted by the Engineering Standards Committee for this class of insulation, viz., 75° C., is not likely to be exceeded on the stator.

Similarly on the rotor, the temperature rise of the copper inside the bell at the hot end of the rotor might reach

$$7{\cdot}8 + 44{\cdot}0 + 20{\cdot}8 = 72{\cdot}6^\circ \text{ C.}$$

if no heat were to flow towards the cool end, but in point of fact the solid rotor offers better conditions for the flow of heat than the laminated stator.

The same argument applies to the maximum temperature of the iron parts.

In the absence of suitable data it is not possible to predict the actual temperature rise closely, but enough has been said to show they should not exceed the permissible limits, and this is what chiefly concerns the designer.

6. EFFICIENCY.

In computing the efficiency we shall estimate the losses from those calculated for full load at a power factor of 1·0. It will be noticed that the constant losses (iron and mechanical) are much larger than the variable losses (copper losses), especially at the lower loads. Consequently, in estimating the efficiency, it is not of much importance to calculate the copper losses very accurately. At the same time, the stray loss produced by the stator current should be included, as this affects the steam consumption as well as the heating.

In passing, it may be mentioned that there is no standard method of computing efficiencies of turbo-generators at present in this country, with the result that there is a tendency for every manufacturer to include as little additional loss as possible in his efficiency guarantees, and merely give the pure copper loss calculated with the resistance, hot or cold, as the practice may be.

In the following tables the losses have been rounded off to the nearest kilowatt.

Efficiency at $\cos\varphi = 1{\cdot}0$.

Load	5/4	4/4	3/4	2/4	1/4
Iron loss in core and teeth	55	54	53	52	51
Stator copper and stray loss	32	20	11	5	1
Rotor copper loss	8	6	5	4	3
Mechanical loss (excluding bearings)	50	50	50	50	50
Total losses	145	130	119	111	105
Output	2,500	2,000	1,500	1,000	500
Input	2,645	2,130	1,619	1,111	605
Efficiency in per cent.	94·5	93·8	92·7	90·0	82·8

Efficiency at $\cos\varphi = 0{\cdot}8$.

Load	5/4	4/4	3/4	2/4	1/4
Iron loss in core and teeth	60	59	58	57	56
Stator copper and stray loss	50	32	18	8	2
Rotor copper loss	15	12	9	6	3
Mechanical loss (excluding bearings)	50	50	50	50	50
Total losses	175	153	135	121	111
Output	2,500	2,000	1,500	1,000	500
Input	2,675	2,153	1,635	1,121	611
Efficiency in per cent.	93·4	92·9	91·7	89·2	81·9

(*To be continued.*)

The Dielectric Strength of Thin Insulating Materials.

According to some researches described by Mr. F. M. Farmer before the American Institute of Electrical Engineers in December, 1913, the apparent dielectric strength of thin insulating materials, when tested between circular disc electrodes, was found to depend on the diameter of the disc. For example, with varnished cambric sheets it diminished by 13·4 per cent., with an increase in disc diameter from 1·1 to 5·1 cms. In the circumstances the electric field across the sheet is presumably uniform, and the above effect was, therefore, accounted for by the "weak spot theory," i.e., that in a large disc more accidental weak spots would be located than in a small one. This theory, however, can hardly be applied to explain the phenomenon in the case of thin films of oil, in which weak spots are presumed not to occur. The problem has therefore been the subject of further research at the Massachusetts Institute of Technology, by whom some results are communicated to the Journal of the Franklin Institute. An important point was that the diminution in dielectric strength did not occur when the increased surface of electrode was secured by a number of adjacent disconnected surfaces. This seems to dispose of the weak spot theory. It is now suggested that when a high alternating E.M.F. is impressed on two discs very near together, extremely high frequency discharges take place which injure the surface of the dielectric and pave the way for a breakdown. When the disc electrodes are increased in diameter the frequency of these oscillations would be lowered, but their amplitude and energy increased. If, however, the electrode is broken up into separate elements [illegible] such oscillations would be damped out.

Switchgear Standardisation.*

By C. C. GARRARD.

(*Concluded from p. 707.*)

Summary.—The author considers the various parts of switchgear which can, in the present state of the art, be standardised with advantage.

SWITCHBOARDS.

The only British standards (apart from some minor requirements in the Institution Wiring Rules) as regards switchboard construction which have been as yet established are contained in the official regulations issued by the Home Office and Board of Trade. Clearances, general arrangement of apparatus and connections, dimensions of slabs used in switchboard construction, &c., could be standardised.

As regards high-tension boards, a code of principles should be set up which would guide central station engineers and manufacturers in selecting the type of board most suitable for the particular service required. This matter is of particular importance in view of proposals for linking-up and bulk supplies, which are likely to be considerably extended in the future.

Cellular or Cubicle Type of Switchboards.—One of the most beneficial principles of high-tension switchgear construction is the cellular principle originally enunciated by Dr. Ferranti. As of late the desirability of this method of construction has been questioned, the opportunity is now taken of raising a discussion on the subject. In the author's opinion all high-tension boards should be based upon this fundamental idea.

The author refers to some designs suggested by the Commission on High Tension Apparatus set up by the Swiss Elektrotechnischer Verein.

LIGHTNING PROTECTIVE GEAR.

The horn gap forming as it does a necessary constituent of very many forms of lightning arrester should be standardised as regards its shape and jump over voltage. This latter depends partly upon the diameter of the rods used in the construction of the horns, and this must therefore be specified. As regards material, both galvanised iron and copper yield good results.

Great diversity exists in present-day practice as regards the size of choking coils used for the protection of machinery against the entrance of dangerous currents. It should be possible, however, to lay down standards (expressed in millihenries) of inductance in the various cases.

Reference may be made to the general formula put forward by Coursey for coils of small radial winding depth,† and that proposed by [illegible]

There can be little doubt that the future development of overhead electric transmission is bound up in no small degree with the question of [illegible] protection against lightning. Of late, two methods for the protection of large systems have come to the front, namely, the [illegible] condenser system and the electrolytic.

A very considerable amount of development work in connection with the [illegible] arrester has been carried out in the private [illegible] manufacturing firms. In view of the importance [illegible] from the point of view of the future of the British [illegible] and of the export trade, it is desirable that [illegible] published, as the constants of such a vital [illegible] common property, just as are, for [illegible] properties of the commonly used dielectrics.

DISCUSSION.

[illegible] high pressure [illegible] considered by the Engineering [illegible] that Institution and [illegible] representing [illegible] conference on [illegible] up the matter [illegible] the question [illegible] standard [illegible]

Capt. A. M. TAYLOR said that he wished to look at the question from the point of view of the operating engineer, and also from the point of view of the inventor. He hoped that if and when any committee was set up for the purpose of standardisation care would be taken to secure the advice of the operating engineers. As regards the switchgear for extra-high-tension work, and for very large powers, the operating engineer's experience was, or should be, of the greatest value. Any committee consisting merely of distinguished men, whether scientific or commercial, might be led to form conclusions doing a grave injustice to a particular class of apparatus. Let it be granted that (1) there must be special types of switch for special purposes; (2) there must be different types of switch for the breaking of large powers and for the breaking of small powers; (3) there must be every possible opening left for inventive talent; then, as far as oil switches are concerned, he would feel more ready for standardisation. Dr. Garrard hinted about doing away with two-step switches. He (Capt. Taylor) believed such switches would find a field of their own in those cases where there was trouble from excitation currents at the closing of the switch, as, for instance, in the case of a high-tension line where the current was stepped up and then down again, and where switchgear was only employed on the low-tension sides. Or, again, in the case of the use of static frequency changers. Take the case of the method of opening the break. He hoped that some standardisationist who had no actual experience of the behaviour of oil switches on a large scale would not come along and say "Why do we want two different types of switch? Let us merge the horizontal-under-crossarm break with the vertical circular-oil-pot break, and have only one type." He believed that that would be the greatest possible mistake. He agreed with Dr. Garrard that it was very difficult to get new types of switch tested under great powers. Even in standardising performances there was a difficulty. For instance, Dr. Garrard gave a curve which, though it might possibly represent experimentally the results obtained with a particular switch—perhaps with a horizontal-under-crossarm break—would give totally wrong results for, say, a switch like that of the General Electric Co. of America, because the head of oil was not specified, and the oil that is used was not employed to the best effect. The rating of oil switches was misleading. One maker said his switch would break, a certain number of times in succession, the current represented by so many kilowatts connected to the 'bus bars. Another maker claimed that his switch would break twice that kilowatt capacity. It might be found that in the second case the time-lag of apparatus and the wiping out of the generator field had been traded upon, so that the kilowatts actually interrupted were perhaps only half those interrupted in the first case. He preferred the open type of 'bus bars and connections, isolating switches, &c., provided insulators were so substantial that they could not shear, isolating switches so rigidly locked that they could not be blown open, connections between 'bus bars and switches so rigid that they could not be bent by the current, and that flame tightness between cell and cell (as also explosion proofness) was above suspicion. With regard to the non-inductive resistance shown at (A) in Fig. 6 of the Paper, this did not seem to be a very happy arrangement, since it must add considerably to the inertia of the moving parts, which it was desirable to keep down to the absolute minimum. With regard to the form of brake shown in the same figure, he had known cases where the central insulator (left hand drawing) sheared horizontally; apparently because of unequal thrust combined with side thrust on the two ends of the bridge piece. Most makers employed porcelain insulators; these did not stand up to the "hammer blow" of the magnetic repulsive action of the current, which he had proved, from effects on the main 'bus bar insulators, to be enormously more serious than would be gathered from a calculation of the forces brought into play by the current. The breaking effect on the porcelain must, therefore, be purely a matter of the suddenness of the establishment of the magnetic force. For these, and other reasons, he rather doubted the advisability of having anything but a straight line break when very large currents had to be considered.

Mr. E. W. COWAN, referring to the specifications for brass and gunmetal [illegible], said it would be an advantage if the Author put in another alloy [illegible] high conductivity cast metal. Gunmetal had a very high resistance, and so had brass. The alloy which was sometimes called red metal he thought should also be standardised. It could be made of as high conductivity as copper, and was without the objections to cast copper from the foundry and working point of view. The knife switch described by the Author would be better if there were a multiple contact with [illegible] of copper one above the other, thus making four areas of contact [illegible] instead of one. Too much attention had been given to the area and too little to the number of points of contact. He thought Dr. Garrard's millivolt method of standardisation of conductivity on contacts should be used more than it appeared to be in central stations. In the [illegible] switches which heated alarmingly when the fitters left [illegible] with a millivolt meter, and was able to help the [illegible] drop of about one tenth. In the case [illegible] he poured the oil out and wiped [illegible] the [illegible] the ... [illegible], and

* [illegible]

† [illegible]

increased the conductivity about four times. If the contacts were clean when the oil was poured in they remained electrically clean. He also thought the head, and not the quantity of oil, was the most important factor. Mr. Price, of Johannesburg, got over the trouble of explosions, attributed to incandescent vapour rising from the oil in the switches and coming into contact with the oxygen, by enclosing the contact in a sort of diving bell or cup of insulating material hanging all round the contact and with only a slot opening at the bottom. This made the vapour travel down and round the corner, and then through more oil. He was in favour of more standardisation.

Mr. BAKER (Kartret Engineering Co.) thought the manufacturers should do the standardisation work. It was very necessary to get the sizes standardised.

Mr. H. H. BERRY said he had studied the methods of the body which provided the National Electrical Code of America, and he wished to urge that the process of standardisation here should not be made the fetish which it had become in the United States. In his opinion they had gone the wrong way to work from the national point of view. The underwriters had set up a laboratory, and the controlling body were mainly the people who made the articles which had to be tested, and the income of that body was derived from the manufacturers. Apparatus had become standardised, to the elimination of simpler apparatus that more effectively performed the same purpose, purely because the latter was not interchangeable, and this practically placed an embargo on invention.

Mr. E. T. WILLIAMS: If manufacturers let their vested interests stop the work of standardisation they would be standing in the way of their own advantage. Any tendency of standardisation to cut out ingenuity and invention must be closely checked. The Author referred to the static condenser and the electrolytic systems of lightning arresters having been developed on the Continent and in America respectively. The feeling abroad was that if one wanted anything taken up he must go to the Americans or (before the war) to the Germans.

Mr. A. E. GOTT said standardisation should be applied to processes of manufacture as well as to the articles manufactured. He did not attach much importance to the brass specifications, which were more mechanical than electrical. He had known a workman to secretly re-introduce arsenic to flux metal and make a nice casting, with the result that the conductivity was reduced to 30 per cent. Fifteen years ago he introduced millivolt methods to test knife switches, and it was found that a switch properly scraped, irrespective of its current, would give 5 to 10 millivolts across its contacts. Nothing was said in the Paper about soldered connections. A good soldered connection would not drop more than about 1 millivolt, whereas a badly made one would drop as much as 50. He did not think the taps suggested for switch bolts were suitable. He suggested the fine steel conduit threads as an alternative.

Prof. MCGREGOR MORRIS said standardising should be done in a broad-minded and fair way which would not limit ingenuity. He suggested that rolled aluminium might take the place in switchgear of material now used. A small contact which was efficient was far more important than the actual area. It might be worth while to make tests of perforated faces on switches, the oil being forced in as a series of jets. Various materials in fuses broke circuits in different times. If fuses of copper and tin in series with one another were put on a short-circuit the copper cleared the circuit three times as quickly as the tin. This idea could be utilised so that a fuse at a distance would fuse, leaving another unblown at the station.

Mr. A. H. ELLIS said he was responsible for the electrical end of a large undertaking in London. Co-operative action on the part of designers, manufacturers and users was desirable to secure standardisation. Knife switches should be standardised on some mechanical line. A 10,000 kw. turbine should not be dependent on a little switch with paltry contacts. No studs should be of less than ½ in. diameter on a central station switchboard. The thread in a nut should be equal to the [illegible] and the nut should be large enough to take the grip of a standard [illegible] spanner. The blowing out of a switch tank was not uncommon. [illegible] should be constructed of boiler plate of high tensile steel, and be supported by strong bolts. He thought the breaking capacity of switches had not yet been satisfactorily proved. It might be better to make a multiple break switch than to increase the opening. He [illegible] type of two-step switch had been tried in the States with satisfactory results. He did not think there was any such length of break as the Author's curves showed. The minimum was about 12 in. and it went up to about 40 in. The length of break was not a function of the capacity of the switch. He had a switch taking about [illegible] k.v.a. and only using ¾ gallon of oil. By [illegible] he had got a fuse which, when put across the terminals on a 100 kw. 400 volt circuit, stood the test from 25 to 100 amperes.

Mr. W. [illegible] said he did not think general standards would further the object in view. [illegible] products, and had to [illegible] patterns [illegible] the Author said, oil switch [illegible] in a state of [illegible] at such a time [illegible].

Mr. [illegible] [illegible]

Dr. GARRARD, in his reply to the discussion, said the matter of standardisation was of high national importance. In the large manufacturing works with which he was connected they were obliged to make practically every detail in their products. Those details should be manufactured by concerns specialising in them and producing them cheaply and to accurate limits. One of the chief troubles to be got over was the jealousy between manufacturers. He hoped the question of standardisation would be regarded from a broader-minded point of view than hitherto. There could be standardisation of performance as well as of details; such things as telephone and electric supply services were standardised in America. He disagreed with the idea that standardisation hindered progress. The engineer, in making inventions in switchgear, in the absence of any standardisation, had to start from the beginning, whereas if there were standardisation he would start from that level and proceed to higher standards and greater developments.

High Temperature Processes and Products.

In the final of his series of Cantor Lectures before the Royal Society of Arts, Mr. C. R. Darling on Monday dealt with the products of the electric furnace. One of the most important and essentially British was vitrified silica ware. It must be said that the manufacture of this was, in the first instance, due to Prof. Boys, who obtained fine threads for suspending galvanometers by fusing quartz. This material had remarkable properties. In its manufacture it was worked in the same manner as glass, except that an oxy-hydrogen blow-pipe was used. Owing to the expensive character of rock crystal attempts had been made to use high-grade sand with success, although the resultant material was not so clear. It was, however, very much cheaper to make. This particular class of material was used for the muffles of small electric furnaces, in which a temperature of 1,000 deg. was maintained, these being wound with nickel chrome wire. Such furnaces were now used by the thousand for the purpose of hardening dies and gauges, the desiderata being a clear atmosphere and certain control of the temperature. In some instances these furnaces were also used for gear hardening. Another use for this silica was in the condensing plant in the manufacture of nitric acid and sulphuric acid, it being acid but not alkali proof.

Another important product of the electric furnace was carborundum, which was due to Dr. Acheson, in the United States, who, following up some early work of Moissan, found that hard crystals were deposited after passing a current through a mixture of sand and coke. The first sale of this material was to a jeweller, and was made at a price of £175,000 per ton, the output of the works at first being 1 oz. per day. As its use for grinding became better known the output increased, and the price rapidly dropped first to £2 per lb., then to a guinea, and then to 2s. per lb. After mentioning some of the uses to which carborundum is put and the extent to which grinding by means of it is taking the place of machining operations, attention was called to the fact that it will not grind steel, for which purpose a harder material, alundum or aloxite, has been introduced. This is produced by fusing bauxite, the most important deposits of which are in the South of France, although there are some in County Antrim, which are of uncertain composition. After being treated at the mines in South France the material is sent to the Manchester works of the Carborundum Company, and there converted into grinding stones, &c. The Norton Company, of Canada, also owns some American deposits of bauxite. Alundum or aloxite has been found to act well as a refractory, having a melting point of 2,050 deg. An interesting feature of the use of this is that if a silica muffle is wound with platinum wire, the wire will not withstand the heat, whereas if the same wire is wound round an alundum muffle it will stand up well.

Finally, mention was made of the electric furnace for refining steel. There are 70 such furnaces in Sheffield, having an output of [illegible] tons per annum. They have also been installed at Braintree, in Essex, and at Letchworth. In fact, said Mr. Darling, the refining of steel in the electric furnace could economically be carried on wherever cheap power was available. The [illegible] type of furnace, in which the charge was heated both at the top and bottom, was very much in favour in Sheffield.

The lecturer concluded by remarking that the future of high temperature processes [illegible] [illegible] steel.

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Load Curves and Load Factors.

In these days there is frequent reference to the effect of load factor on the economical operation of power stations, and probably the importance of this aspect is beginning to be realised even by the layman, though he may have a very vague idea as to what load factor really is. Although load curves of a given station may look very satisfactory when selected for certain days the state of affairs is considerably altered when Sundays and other disturbing periods are taken into account, and thus it may be that the yearly load factor, which is the thing that counts, is comparatively poor. To those who handle such matters all this is, of course, well known, but it is sometimes not fully realised by those who are not in close contact with the subject.

In dealing with questions of this kind graphical methods undoubtedly have some advantage. They serve to make things plainer, and the whole thing often becomes still clearer if models can be constructed to show what is taking place. Two or three years ago we remember that an account was given by a French engineer, Mr. Max Du Bois, of what he termed contour maps of electricity supply stations. These were described briefly in The Electrician of Sept. 3, 1915. The map is in the form of a relief map, the distance east and west, for example, representing 24 hours, whilst dimensions north and south show the time of year. If a section of the map is taken east and west at any date it gives the load curve for that date. It is, in fact, made up of load diagrams on edge. We notice that the subject has now been brought before the American Institute of Electrical Engineers by Mr. W. Le Roy Robertson and that it has also been used by Mr. H. A. [illegible] of the Pacific Light & Power Corporation of Los Angeles. The method consists of plotting the load curves on cards which are then cut so that the curve forms the top line of the card. These cards are then put together in card index fashion to give a graphical record for the whole year, forming a sort of relief map. Assuming that the cards taken are of a height corresponding to the maximum annual load of the station then the upper part of each card shows the additional number of units which might have been supplied by the station if the yearly load factor had been 100 per cent.

Although such maps may not convey more to the trained engineer than the load curves to which he is accustomed, we can quite believe that they would bring the position of an undertaking more clearly before the minds of directors at a board meeting, who would see more easily the desirability of filling up valleys actually portrayed before them [illegible] of this kind. Such a model brings out, for instance, quite clearly the effect of redistribution of the load, such as takes place on the introduction of "summer time." Mr. Robertson deals with this point in the case of one of the stations in the United States and shows that the "afternoon peak" at present existing would largely disappear. [illegible]

Mr. Du Bois used the method of contours to determine the extent to which reliance must be placed on a second station. For example, if there is a question of utilising water power for carrying the load above, say, 4,000 kw., a planimeter is run round any contour lines for 4,000 kw., and thus a fair estimate is obtained of the water necessary for the purpose.

Where such problems as the relative values of water power and steam reserve have to be demonstrated to financial people who have little or no technical knowledge we can quite believe that such methods may be of value.

Review.

A Treatise On the Elements of Electrical Engineering. Vol. I. Direct and Alternating Current Machines and Systems. By W. S. Franklin. (London: Macmillan & Co.) Pp. x.+465. 19s.

This book is on the whole a good attempt to present a connected account of the principles governing the design and operation of a very wide range of electrical machinery and apparatus. There is no doubt that it would form a good text book for junior students in American universities, and it could be read with profit by those of the same class over here, who were able to appreciate certain differences in practice and in treatment of the subject.

The author's work of about 12 years ago, written in conjunction with Mr. Esty, and published in two volumes, devoted respectively to continuous and alternating currents, forms the basis of this book. The original matter has been fairly judiciously condensed by the elimination of detailed descriptions of machines which have gone out of date with the result that modern theoretical developments receive more adequate treatment within the limits of one volume of moderate size. It is not quite obvious why the author should take such pains to assure us, as he does, that the original two-volume work is still in print.

The book is divided into four parts, of which the first, devoted to a review of elementary and applied electricity and magnetism is, perhaps, the most interesting, as it includes, probably for the first time in a text-book of this sort, a well-written chapter on the electron theory and a description of such things as a Coolidge tube, a process for precipitating dust electrically, and the vacuum valve as rectifier, receiver and generator of electric oscillations, accompanied by diagrams of the necessary connections. There is rather too much insistence on a given arrangement as it stands, as being *the* thing, a tendency very noticeable wherever the author is describing actual machinery and apparatus, and probably due to the dominating influence exerted by the standardised practice of the great American electrical corporations on the industry.

The author's gift of lucidity is great, but occasionally his enthusiasm for putting things in a popular form betrays him into clumsy forms of expression, as when he speaks of the "side push" on a wire carrying current in a magnetic field. The abvolt, abampere and abohm, as names for the corresponding absolute units sound curious at first, but there is no reason why their use should not spread, as a certain economy of speech and text can be attained by their use.

The second part of the book is concerned with direct-current machines and systems, and as it stands it is unduly compressed. The appendices "B" and "C" dealing with characteristics and armature winding should have been put in the text in this section. The opening chapter on electromagnets and the magnetism of iron contains among others two extraordinary footnotes. In one, the author doubts the wisdom of including the chapter in the book at all, which he need not have done, as the subject is adequately treated and is the obvious introduction to the rest of the section; and in the other, he quite rightly informs the reader that his method of arriving at the formula for the magnetising force within a long solenoid carrying current is not as good as that given by him in another

book. Then why not give the better method at once? The statement made on pages 220 and 221, as to the amount of compensating winding required to prevent field distortion in continuous-current machines, is not correct.

The treatment of the elementary theory of alternating currents in Part III. is good, the diagrams being clear and well chosen. The derivation and connection of three-phase windings with and without the fourth line is especially well explained. It would have been an assistance if in all the vector diagrams an arrow showing the direction of rotation of the figure had been included.

The discussion of alternating-current machines and systems in Part IV. follows accepted lines, except that regulation problems might be more easily explained by using the characteristic triangle of the machine or transformer, and the deduction of the circle diagram is rather roundabout. Important types of machines such as the motor converter and the compensated repulsion motor receive no notice.

The inclusion of a short appendix on differential equations is of doubtful value, as the students to whom this book will chiefly appeal should get all that and much more in their mathematical courses. W. C. CLINTON.

Annual Load Relief Map, Peak Load and Load Factor Analysis.*

BY WM. LE ROY ROBERTSON.

The annual load relief map is a device for visualising the entire load of the year. Each daily load diagram is marked off on cardboard and cut out. The cards are stacked up in proper daily sequence, mounted and provided with graduations for kilowatts, hours of the day and months of the year, all properly arranged. The annual load relief map is illustrated in Fig. 1, showing the Philadelphia load during the year 1916.

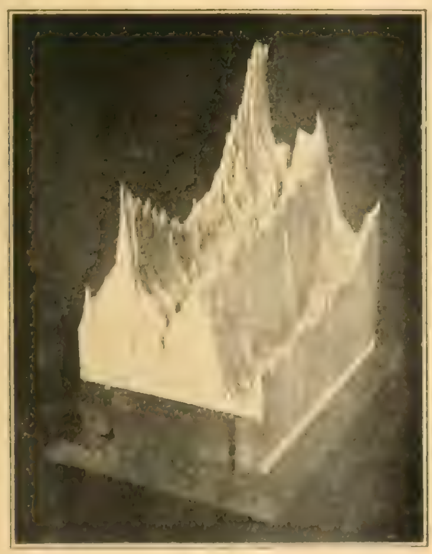

FIG. 1.

giving a combined peak greatly exceeding any other peak, which rapidly increases in height until the middle or latter part of December, when it becomes the greatest peak of the year. As the spring months approach the combined peak diminishes, and finally near the end of March, disintegrates, forming again the two separate peaks. While the above is a well-known fact, the annual load relief map presents the changing condition in a most striking manner.

During the past year or more 12 European countries have adopted the plan of setting the clock one hour ahead during the summer months, in order to utilise a greater amount of daylight. Nova Scotia has also adopted the plan. The cities of Detroit and Cleveland have practically accomplished the same thing by adopting Eastern Standard Time; and, further, the Committee on Daylight Saving of the Chamber of Commerce of the United States, in its report of February 1, 1917, recommended that Congress adopt the plan throughout the United States.

The annual load relief map will be found useful in conjunction with the study of the effect of daylight saving on peak loads. Advancing the clock will have the same effect as shifting the day load back from the night load. By shifting back the day load the valley [illegible]

FIG. 2.

[illegible]

[illegible] and considerable variation in the individual load diagram may take place before the load factors are affected.

The author tabulates load factors of the base and top sections of the load, corresponding to a number of selected dividing lines, and repeated for several annual load factors of the total load.

The results are most illuminating. For instance, in the case of a central station having an annual load factor of 40 per cent., there is 50 per cent. of the load—*i.e.*, top load which has an annual load factor of only 6 per cent.—*i.e.*, there is equipment in such a plant sufficient in capacity to carry 50 per cent. of the maximum load which is idle 94 per cent. of the time. Similarly with a 30 per cent. annual load factor there is equipment in this plant sufficient in capacity to carry 60 per cent. of the maximum load which is idle 95 per cent. of the time. Any one having difficulty in conceiving these facts will find that the annual load relief map will aid in making them clear. Here the "dividing line" becomes a dividing plane. The top section of the load above the plane for the entire year is indeed very small when the dividing plane is at 50 per cent. of the maximum load [illegible]

[illegible] void between the contour of the load and a horizontal plane placed at the tip of the highest peak represents the business [illegible] station can theoretically carry along with its present business without increasing its equipment. If the central station load factor is 33 per cent., then this void represents 200 per cent. of the business already carried. In cutting out the cards of an annual load relief map, if the upper half of the card is saved and [illegible] the mass of cards will represent the additional business [illegible] in theory by a central station without increasing [illegible]

The familiar daily load diagram is plotted by practically all electric light and power companies, but when considering the load throughout the year it is difficult to obtain a comprehensive idea of the whole, since it is necessary to glance separately at the greater portion of 365 sheets. Such a record locks up a desired vision in [illegible]

Correspondence.

ELECTRIC POWER SUPPLY IN GREAT BRITAIN.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The interim report of the Coal Conservation Sub-committee which was released about two months ago, has so far evoked very little serious criticism, and whilst I realise that, perhaps, it is not advisable for the opponents of the report to [illegible] to disclose their side of the case, yet I feel that [illegible] that some of the one-sided statements should be [illegible] and I venture to offer the following comments, in the hope that others will take up the matter, and not allow those unacquainted with the details to swallow the report as [illegible] for the health of our electric power supply.

[illegible] at the outset that the report is dated April 16, 1917, and the fact that it has been kept secret so long [illegible] immediately raises [illegible]

I have read the report several times, and fail to find anything in it that can be said to [illegible] unless such [illegible]

[illegible]

Some enlightenment, however, is vouchsafed in appendix D, page 26. It is there stated that in regard to the North East Coast operations that "its development and the growth of its profit-earning capacity were considerably delayed by the work which had to be done from time to time and the sacrifice that had to be made to secure uniformity of system." If this has been the case in one district, what will be involved for the whole of Great Britain?

The location of some of the larger existing power stations is criticised, but here again not the slightest indication is given that suitable sites are obtainable which will embrace the three essentials—viz., (1) an ample supply of water, (2) close proximity to coalfields to effect saving in transport, (3) to be within reasonable distance of the districts to be supplied.

The Newcastle District is held up as a pattern for the rest of Great Britain, but, of course, no more ideal district could be found for such a scheme, and this is admitted in appendix D, on page 26 of the report, where it is stated that in coal, iron and shipbuilding, the North East Coast figures represent respectively and approximately one-fifth, one-third and one-half of the nation's output.

Again, the prices charged on the North East Coast are compared with the Lancashire area. Here, of course, is the old saying that figures can be made to prove anything, and the usual misleading "average" is taken to justify the claim.

I venture to say that if the prices charged to individual consumers on the North East Coast be compared with those of municipalities, where the consumers take equal quantities of power under similar conditions, there will not be found to be that large difference which the report suggests, particularly bearing in mind that the municipalities pay a fixed interest on their capital, and also make definite repayments of capital each year.

Great stress is laid upon the necessity of one large controlling body of private interests for the electric supply, and comparison is made with the railways, but there is this immense difference—under the proposals for the electric power supply there would be an absolute monopoly; but this has not been the case hitherto with the railways—for instance, a passenger from London to Edinburgh had the option of not less than three routes, and each company did their best to make that particular route the most attractive.

We have heard a great deal lately of the soullessness of the War Office, and one knows to their sorrow what Government control means in business, and many examples could be quoted of the deterioration of public services once they have become merged into one immense individually-controlled concern, such as is now proposed for the electric power supply of Great Britain—soulless is, I think, the best description.

As against these examples let us consider the tramway systems of Great Britain. Can it be said that the Liverpool, Manchester, Leeds, Birmingham, Sheffield and Glasgow (to quote a few) systems are examples of municipal mismanagement, and can any company managed undertakings show better results than these? Similarly, with electric power supply, it has yet to be *proved* that private ownership and management is better than a municipal one.

The fetish of super-stations, I know, is the reply, but such reply can only be accepted if backed up with definite proof that the change is going to be a sound one not only nationally but financially, unless, of course, the nation is prepared to pay for the advantage it will obtain in the calculated conservation of its coal supply. It is monstrous to suggest that an individual must pay more for his electricity in order to benefit the nation by conserving the coal supply.

The aspect of the question from the electric supply legislation point of view is laboured at great length, and here again the municipalities come under the whip.

It is well known that the desire of the power companies was to traverse all districts and scoop up the large and remunerative consumers, leaving the small and unremunerative ones to the municipality, and this idea is still running in their [illegible] page 16, paragraph 17, also page 14, of the report [illegible] that [illegible] authority take over all existing

undertakings and systems, except "possibly the lighting and small power consumers." Here in a nutshell is the answer to the insinuations made against municipalities in the second paragraph of the footnote on page 13, and indirectly hinted at in appendix B.

It is not that they (municipalities) have undercharged power consumers and overcharged for other services. If anything, the reverse is the case, and innumerable instances could be quoted to show that the sale of power at low prices has enabled the charge for other services to be reduced.

It is the small consumer that is a drag on an undertaking, unless there is a preponderance of large consumers to make the small ones a negligible quantity, and that is why the report suggests the new authority take over the large remunerative supplies, leaving the small and unremunerative ones to local bodies.

Whilst the legislative difficulties of power companies are emphasised, nothing is said about similar difficulties that municipalities experience. They are bound to accept all consumers, large or small, and treat all alike, and they are always jealously watched by gas authorities and others, to see that they do not exceed their legal powers (the recent Hackney case is a notable example).

Very few undertakings have power to hire apparatus or carry out any installation work; all extensions to the plant and mains have to receive the solemn sanction, after due inquiry, of the L.G.B., and the annual interest and repayment of loans have to be rigidly adhered to. The municipality is bound to the four corners of its provisional order area, and any new business, although a sound commercial proposition, is out of the question if there is the slightest suggestion of preferential charges.

Give the municipalities the same power as it is proposed to give to the new electric supply authority, and there is no doubt that the same saving in coal will be realised at a far less capital outlay.

It is amusing to see the pretty little fable at the foot of page 11 resuscitated in a serious Government report. Doubtless the author of it imagined himself to be the only man in London, probably the superman. He appears to have quite overlooked the fact that the station supplying his office light may equally cook another man's breakfast and supply the power for a third man's train. A proposal which has to resort to such arguments for its backing must evidently be a very thin one.

It is also very pathetic to see the feeble attempt made on page 15 of the report to obtain the support of the Labour Party by dangling before their eyes the idea of a universal supply of cheap electricity. Perhaps the authors of the report could enlighten us as to how far this has been realised in all the workmen's houses in that "[illegible]" example of the North East Coast.

In conclusion I would say that it behoves every municipal engineer to carefully study the report and see that *both* sides of the question are fully laid before their respective Members of Parliament, as this is the most effective method of counteracting the attempt being made to take advantage of war conditions to hustle the nation into handing over our electric power supply to the millionaire company ownership whose incentive (according to appendix C, para. E) is "larger profits," or to put it [illegible], coal conservation is mere camouflage for the creation of a huge private monopoly of our electric power supplies.—I am, &c.,

[illegible], Feb. 22. [illegible]

P.S.—The above was written before the "statement" of the I.M.E.A. appeared. To be correct, [illegible] should be "statement of the I.M.E.A. Council."

[illegible]

It will be interesting to watch how the [illegible] will be [illegible].—[illegible]

LONDON ELECTRICITY SUPPLY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the current issue of one of your contemporaries there appears a statement purporting to be the report of the Committee of the Conference of Local Authorities owning electricity undertakings in Greater London, appointed to confer with the Special Committee of the London County Council. The report in question was prepared in draft form for the consideration of the Electricity Committees of the various Councils forming the Conference, and was issued as a strictly private and confidential document.

As a matter of fact, the draft report was considerably amended at a meeting of the Conference held on 20th inst., and even as it now stands, it is only intended to form the basis of discussion with the London County Council.

It is to be regretted that documents intended for Committee use only should be forwarded to the Press, and that editors should consent to the publication of same.

On behalf of the Conference, I wish to state that immediately any definite action has been decided upon between the London County Council and the Conference, full publicity will be given through the columns of the technical and the daily Press.—I am, &c.,

London, Feb. 22. FRED. TAIT.

Hon. Sec. Conference of Local Authorities owning Electricity Undertakings in Greater London.

[As will be gathered from the above, we gave no report of the document in question, and we agree that such publication is wholly undesirab e.—ED. *E.*]

EXCESS PROFITS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The large amount derived from excess profits duty has led to the assumption on the part of Labour that a great deal of profiteering is going on. May I be permitted to point out, however, that before any firm can be said to be profiteering it is necessary for it to be making nearly seven times its pre-war profits. For instance, suppose a firm has made an average pre-war profit of £4,000. Seven times that amount would be £28,000. Allowing for the £200 extra profit permitted by the Act, the amount liable to excess profits duty would be £28,000, minus £4,200, or £23,800. Eighty per cent. of this is £19,040, leaving £8,960 on which income tax at 5s. in the £ is required (£2,240), leaving a net profit of £6,720. The pre-war profit of £4,000 was subject to an income tax of but 1s. in the £ (£200), leaving a net-pre war profit of £3,800, as against the profit "on paper" of £6,720 to-day.

There is, however, a most important point to be taken into consideration. The pound to-day is a very different kind of pound to the pre-war pound, as has been fully recognised by the large advances in wages given to the workers generally. Receivers of dividends are paid with the same kind of pound as receivers of wages, and have to pay the same increased prices for commodities. The pound to-day may be taken roughly as equal to 12s. in pre-war days. Therefore, in order that the firm in question should be placed in the same position as it occupied in pre-war times the net profits should be £[illegible], or as I stated previously, it would have to earn approximately seven times its pre-war profits. [illegible]

[illegible] E. H. [illegible]

[illegible]

The Glasgow Tramcar Accident.

The report of Col. J. W. Pringle on the tramcar accident which occurred on Dec. 5 on the Netherlee to Kirklee route has been issued.

After describing the tramcar, route, &c., the report points out that [illegible] agreed that the accident was caused by high speed, and thinks that he was taken by surprise by finding himself nearer to the curve than he had expected. It is possible that he applied the hand brake too powerfully, with the result that the wheels locked and skidded on the greasy rails. After the accident the car was pulled up on to its wheels, and drawn on the rails into the depot. The wheels were tested and found to gauge, with the flanges uninjured. After a new trolley standard had been fitted on to the roof of the car, as he found by personal inspection, it was possible both to drive and control the car without any alteration to the controller or brake equipment. Mr. James Grierson, permanent way engineer, gave evidence that the only wheel mark found was on the roadway outside the outer rail of the curve. It commenced about $57\frac{1}{2}$ ft. from the tangent point and extended for 6 ft. or 8 ft., but not continuously. On a curve of 60 ft. radius, assuming the centre of gravity of the loaded car to have been 6 ft. above ground level, overturning, due to the effect of centrifugal force, will theoretically take place at a speed of about 19 miles an hour. The safe limit of speed, beyond which danger of derailment or overturning may be anticipated, is 5 to 6 miles an hour. With worn rails a speed of more than 4 miles an hour is inadvisable. The general evidence on the point of speed did not warrant the conclusion that the car was travelling at 19 miles an hour when the accident took place. But curve resistance rapidly increases as rails and flanges become worn, making "slippage" more difficult. In this case also the wheels appear to have been locked by an over-powerful application of the hand brake. There would arise a tendency of the front wheels to bind—particularly on a track with a guard to the inner rail, and of the rear wheels to lift—in the case especially of a tramcar with long overhanging platforms in front and rear of a single truck. That such a lift took place is, I think, clearly proved by the fact that only one left-hand wheel mark could be found outside the rail. The violent jolt resulting from the momentary check so caused would allow of time for the centre of gravity of the car to swing outwards, owing to the load of passengers shifting in that direction. In combination with the action of centrifugal force at the same moment, overturning would result at a lower speed than theoretically required.

There are now two further points for consideration: (1) The sufficiency of the lighting in Queen's-drive; (2) the suitability of lads between the ages of 16 and 18 as tramcar drivers. (1) The Corporation furnished a plan showing the positions of the lighted and unlighted street lamps in the neighbourhood of the site of this [illegible] stated that the lighting was insufficient, that the whole of Queen's-drive was dark, and that the light at the corner of Victoria-road could not be seen until the car was practically on the curve. I think his complaint is justifiable, and that darkness was a factor of importance in this case. As regards general illumination, there is no lighting on the south side of Queen's drive along the [illegible] of tramway track preceding the curve. If similar lighting restrictions obtain over the whole of this tramway [illegible] that darkness of the roads is a distinct deterrent to women offering themselves for training as motor drivers, and accounts in part for the Corporation losing the services [illegible] trained as drivers. Moreover, sharp curves, where speed or stop regulations have been imposed in the [illegible] in both directions [illegible] War has brought in its train unavoidable handicaps to safety conditions in several [illegible] of over darkened streets [illegible] by nervousness [illegible] Public safety [illegible] light in the streets. [illegible] employed on the Glasgow tramways as motormen in pre-war times. The normal number [illegible] and there are now only [illegible] the staff of motormen [illegible] replaced 302 [illegible] and have [illegible] In my opinion [illegible] their full [illegible] they [illegible]

[illegible]

[illegible]

I make the following recommendations:—

(a) That all cars should be brought to a standstill in Queen's-drive and Victoria-road before entering the sharp curve connecting these thoroughfares.

(b) That Queen's-drive be better illuminated by night, and that, in particular, a street lamp be kept lighted on the south side, opposite the tangent of the curve, as a special indication of the stopping place. These compulsory stopping places, imposed by safety requirements, are commonly marked by day by distinctive colouring of a standard. By night the necessity for marking is even greater. The use of a coloured lamp would seem to be appropriate.

(c) That lads shall not be appointed as drivers under the age of 18. Those now so employed should be kept on probation for at least three months; their hours of duty should be shortened, and more frequent holidays granted, until they attain the age of 18.

It is certainly desirable, since substitution by arrangement appears to have proved no success, that women should receive all possible encouragement to undertake the duties of driver, and thus relieve men for military service. Perhaps something can be done to reduce the strain and physical effort involved in tramcar driving—by shortening the hours of duty, by giving longer intervals of rest, by minimising the effects of exposure to weather and by better illumination of the streets.

Parliamentary Intelligence.

MOTOR CAR RESTRICTIONS.

In reply to a question in the House of Commons last week, Mr. Wardle stated that the number of electrically-propelled cars in regular use was very small, and was unlikely to increase in view of the great difficulty of obtaining accumulators, for which a priority certificate from the Ministry of Munitions was required. Economies of electricity and gas were equally important, but the supply of electricity required for driving motor cars did not necessarily entail an additional consumption of fuel, as accumulators were usually charged from generating stations during a period of light load.

Volunteer Notices.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Oxford-street, W. 1.

Officer Commanding, Lieut.-Colonel C. B. Clay, V.D.

Orders for the Week.

Officer for the Week.—Lieut. W. J. A. Watkins.

Next for Duty.—Sec.-Lieut. E. A. Ullmann.

Promotion.—Sapper H. W. Clemson to be Corporal (16/2/18).

Monday, March 4.—No. 3 Company, 6.30–8.30. Recruits' Drill, 6.30–8.30. Signalling Section, 6.30–8.30.

Tuesday, March 5.—Lecture on Demolitions at 6.30. Physical Drill and Bayonet Fighting at 7.30.

Wednesday, March 6.—No. 1 Company Entrenchments, &c., 6.30–8.30. Recruits' Drill, 6.30.

Thursday, March 7.—No. 2 Company Entrenchments, &c., 6.0–8.0. Recruits' Drill, 6.30–8.30. Signalling Section, 6.30–8.30. Ambulance Section, 6.30–8.30.

Friday, March 8.—Musketry, 6.30–8.30.

Saturday, March 9.—Knotting, Lashing and Splicing for the whole Corps, 2.45–4.45. Musketry, 2.45–4.45.

Special Notices.—All drills will take place at headquarters unless otherwise stated.

Recruits will attend for Engineering Instruction with the Companies.

The medical officer will attend for the examination of recruits on Thursday evening at 6.0.

The formation of a band under the direction of Mr. Bailey, as bandmaster, having been approved by the Commandant, any members of the Corps who are musicians and possess their own instruments and who are willing to learn an instrument if instructed, are invited to forward their names to the Adjutant at Headquarters without delay.

Reyrolle's Roll of Honour. Of the employees of Messrs. A. Reyrolle & Co., 2[illegible] joined up at the commencement of the war, and 10 of these have been the recipients of the following honours and promotions:—

Honours.—[illegible], Quartermaster Sergeant, Military Cross; C. H[illegible], Lance-Corporal, Military Medal; J. Kellett, Reg. Sergeant Major, [illegible] Medal; R. W. Lane, Sergeant, Mentioned in Despatches.

Promotions [illegible].—[illegible] others have been made captains and [illegible] lieutenant.

Commercial Topics.

The Overseas Trade Department.

In the House of Commons on Tuesday there was a discussion on the vote of £2,095 for salaries and expenses of the Overseas Department for the year ending March 31 next.

Sir A. Steel Maitland explained that the new department was an experiment in administration. A certain number of officers were contributed to it by the Foreign Office and the Board of Trade, and it was responsible to both. It controlled the foreign services relating to commercial matters. These services were of three kinds. One kind consisted of officers for the British Empire—the Trade Commissioners, and of those it was proposed that there should be 16. The appointment of 13 had been sanctioned, nine had been appointed and a tenth had been selected. Another kind of service was that of the commercial attachés and consuls in foreign countries. For the time being the commercial attachés were under the new joint department, while the consuls were still dealt with by the Foreign Office. It was proposed to extend considerably and to reorganise the whole of the commercial attaché service and to reorganise the consular service also. Sanction had been obtained from the Treasury for a somewhat reduced scheme which could be made operative for the current year. The whole of the consular side of the scheme was under consideration. Before the war everyone was too content to allow questions relating to the development of our foreign trade and that of our commercial rivals to go unanalysed, and competition to go without being properly met. It was necessary under modern conditions that we should have not only information about ordinary subjects, such as about the selling of goods, whether British goods were required in a particular country, whether quotations were made in the proper currency and for the proper weights, &c., but that what was needed was a careful analysis and report from different foreign countries on the whole methods of banking, finance, transport and the other great factors which entered into commerce as an organised system. British consuls in foreign countries would be expected in future to deal with trade in the districts of which they had charge; while the duties of the commercial attachés would be to keep the Government informed as to what was taking place in regard to the general economical state and development of the countries to which they were sent, to see that the consuls did their work properly, and to keep a constant watch in order to see if any system of commercial penetration was attempted by our rivals in the future, and that information would be at the disposal of British traders.

In the course of the discussion there were demands for the publication of the names and qualifications of the men who had been appointed, that the salaries given would be such as to attract business men of the right kind, and that British representatives in foreign countries should know the language of the country in which they were operating.

Replying to the discussion, Sir A. Steel Maitland considered that the experiment which the new department represented was justified, and, although there were drawbacks in the system by which it had to serve two masters, the Foreign Office and the Board of Trade, if it were worked with good-will and understanding on both sides, he thought it would provide the best means of dealing with a difficult situation. Trade commissioners would do service for the Empire and commercial attachés and consuls would serve in foreign countries. He agreed that as regards the latter a knowledge of the language of the country in which the consul was serving was an absolute requisite—at least, any exception would be extremely rare. Ten trade commissioners had been appointed, and the selection committee included, in addition to representatives of the Board of Trade, three outside men of business, Sir Algernon Firth, Sir Henry Birchenough and Mr. [illegible]. What he thought a consul should possess was a really good working knowledge of the trade of the place, and of the principal traders, so that a person who went there ignorant of the place could obtain from him a general idea of the commercial [illegible] of the land, and could be told who were the people to whom he could go with advantage. It was proposed that there should be four grades of commercial attachés, the salary of the first grade being a maximum of £1,500, of the second £1,100, of the third £800, and of the fourth £600. These would be supplemented by [illegible] allowances [illegible] expensive places and by other allowances. [illegible] between the consuls and the commercial attachés the position, when the new system came into force, would be that the consuls, the most promising of them, would be eligible as commercial attachés after going through the four grades. The principal commercial attachés [illegible] would have to collect all the information from the [illegible] and would have to be able to give a really good [illegible] of the country as a whole, and they would have to inspect the consuls and see that they were doing their duty. He trusted it might be possible to get [illegible] which would help to pay for them. [illegible] appointment to the new posts. [illegible] committee composed of representatives of the new department, the Civil Service Commission and [illegible] before he [illegible] recommended the appointment. [illegible] Ministry of Education [illegible] the teaching of modern languages, especially [illegible].

* * * *

Zinc Smelters' Association

An association [illegible] formed by the zinc smelters of the country for the purpose of [illegible] concentrates during the war period [illegible] organisation will be developed [illegible].

Risk of Loss on Stocks.

The Ministry of Reconstruction has issued the following statement:—

Manufacturers are faced with what many of them regard as a serious risk in providing themselves with materials for the resumption of peace-time production on a full scale. It is feared that materials bought at the greatly inflated prices which most things have attained will, with the coming of peace, fall in price, either immediately or gradually, thereby involving the holders in loss. It has been pointed out to the Minister of Reconstruction that fear of this contingency is tending to cause a reluctance on the part of manufacturers and traders to acquire more materials (in readiness for the coming of peace) than will barely tide them over the contracts to which they are committed, and that they are leaving till a later date further purchases for the making of articles for stock. Dr. Addison, recognising that this holding-back is calculated to retard the attainment, after peace is declared, of maximum national productiveness, has appointed a Committee of the Ministry of Reconstruction to go closely into the matter and see whether some way out of the difficulty cannot be devised. The members of this Committee, which is named the Committee on Financial Risks Attaching to the Holding of Trading Stocks, are: Messrs. F. C. Harrison, C.S.I. (chairman), Cecil Budd (Ministry of Munitions), John L. Davison, G. Binney Dibblee, Ernest Debenham, A. W. Flux (Board of Trade), A. J. Hobson, William McLintock, J. C. Stamp, D.Sc., C.B.E. (Board of Inland Revenue), Sir Richard Vassar-Smith, Bart., and Mr. R. C. Smallwood, secretary, Ministry of Reconstruction, 2, Queen Anne's-gate-buildings, S.W. The Committee's duty will be:—

"To inquire and to report as to any measures which could be adopted with a view to securing that manufacturers should be financially in a position to hold stocks after the war, and that reasonable safeguards are established to prevent serious financial losses as a result of possible depression following on a period of great inflation in respect of stocks of materials required for industry." Any body or association of important trade interests which wishes to have an opportunity of stating a case or presenting its views on the questions being studied by the Committee is requested to communicate with the secretary.

* * * *

An Association of British Agents in New Zealand.

H.M. Trade Commissioner in New Zealand calls attention to the fact that the New Zealand Association of British Manufacturers and Agents has been formed to further the interests of British trade in New Zealand.

The various sections include one for electrical manufactures, motors, machinery and hardware, and another for chemicals, paints and oils. The annual subscription is £2. 2s. for manufacturers and £1. 1s. for agents in New Zealand. The secretaries are Mr. H. D. Vikery, 100, Custom House Quay, Wellington (P.O. Box 848); Mr. H. E. Simmonds, 66, Endean's-buildings, Auckland (P.O. Box 993); Mr. H. Antill Adley, Chamber of Commerce, Canterbury; and Mr. W. T. Monkman, Bond-street, Dunedin.

Electricity Supply.

Extensions.

Brighton. The Corporation has applied to the L.G. Board for sanction to borrow £10,000 to cover the cost of the mains, &c., for giving a supply of electricity to the proposed [illegible] factory.

Buxton. The Council is recommended to put down a gas-driven generating set and to dispense gradually with the existing steam plant; to put down a storage battery double the size of the present one, to provide workshop tools, &c.; also to abolish the [illegible] lamp fittings and to substitute for them more serviceable and efficient lanterns.

Glasgow. The Electricity Committee recommend that application be made to the Secretary for Scotland for authority to borrow £750,000, which, with the unexhausted borrowing powers, will meet the requirements of the department for 12 months. The estimated expenditure in connection with Dalmarnock station is £511,000.

Hackney. In regard to the proposal to borrow [illegible] for generating plant and £28,000 for boilers, the L.G.B. state that they consider that it is [illegible] that the loans [illegible] Hackney Council [illegible] 12 years [illegible] included for [illegible] within a [illegible] period.

[illegible]

General.

Birmingham. [illegible]

Dover.—The borough electrical engineer (Mr. L. W. Woodman) and the tramways manager (Mr. E. Carden) have tendered their resignation.

Edinburgh.—The salary of the city electrical engineer (Mr. F. A. Newington) has been increased by £100 to £950 per annum.

Fleetwood.—The salary of the electrical engineer (Mr. W. H. Miller) has been increased by £25 per annum.

Sheffield and Rotherham Electricity Supply.—Rotherham Corporation last week approved of the proposal of the joint sub-committee of Sheffield and Rotherham to obtain a report from Sir John Snell and Mr. Charles Mertz as to the best method of affording a supply of electrical energy to Sheffield and Rotherham and the districts surrounding, including a supply of electricity to the South Yorkshire coal owners.

Tottenham.—As the supply of arc lamp carbons is getting exhausted, the North Metropolitan Electric Power Supply Co. suggested to the Urban Council that the street arc lamps should be removed and incandescent lamps substituted therefor.

In November, 1916, the Council asked the company to discontinue the arc lighting, and to fix incandescent lamps on certain of the existing columns, but the company were unable to comply owing to orders under the Defence of the Realm Regulations. The substitution of incandescent lamps will give effect to the Council's wishes, and the engineer reported that a saving of over £1,000 per annum will be effected.

Electric Traction.

City & South London Railway.—The Board of Trade has extended for one year from Aug. 15, 1918, the time limited by the City & South London Railway Act, 1913, for the construction of works authorised by that Act.

Huddersfield.—The salary of the tramways manager (Mr. R. H. Wilkinson) has been increased from £500 to £600 per annum.

Post Office (London) Railway.—The accounts for the period ended March 31, show a total expenditure of £600,128, which comprises the following items:—

Preliminary expenses, professional fees, &c., £27,172; experimental plant, £5,467; tunnelling, £495,717; stations, £21,948; earthworks, &c., £10,051; land, buildings and easements, £37,752; electrical equipment, £2,016; lifts, conveyors, &c., £4. In addition, £2,073 was expended out of the Post Office Votes prior to August, 1913, in connection with preliminary investigations. The balance of authorised issue unexpended for the period under review was: In hands of the Post Office, £12,871; unissued, £499,871; making a gross amount of £1,100,000.

Tramway Advisory Committees.—A conference of members of the various tramway undertakings in the Midlands was held at Birmingham on Friday, when it was decided to form an advisory committee consisting of an officer of each undertaking in the area.

Mr. A. Baker (manager of the Birmingham tramways) was elected chairman and Mr. R. L. Horsfield (manager of the Walsall tramways) honorary secretary.

Advisory Committees have now been formed in all areas in the United Kingdom.

Telegraphy and Telephony

Radio-Telegraphy in China.—The Chinese Minister of the navy has concluded an agreement with Messrs. Larsen & Co., of Copenhagen, for a loan of [illegible] in order to construct a number of radio-telegraph stations for naval and military purposes. During the [illegible] the Danish firm which is to carry out the [illegible] in conjunction with Chinese officials.

Radio-Telegraphic Convention.—The Republic of Cuba has ap[illegible] of the International Radio-Telegraphic Con[illegible] to the final Protocol.

Miscellaneous.

Advisory Council of Ministry of Reconstruction.—The Minister of Reconstruction [illegible] an Advisory Council to [illegible] submitted to the Depart[illegible]

[illegible]

Niagara Falls Power Extension.—[illegible]

Tenders Invited and Accepted.

Electrical Stores.

Belfast Tramways and Electricity Committee invite tenders for the supply of materials, including lubricating oils and petrol, ironmongery, v.b. insulated cable, v.i.r. cables and wires, electrical accessories, lamps, carbons and carbon brushes, refined Trinidad bitumen, bitite strip, prepared tape and rubber tape, joint box compound, feeder and section pillars, &c.; electricity meters, m.d. indicators, time switches and cut outs. Forms of tender from the city electrical engineer (Mr. T. W. Bloxam), East Bridge-st, Belfast. Tenders to the Town Clerk, City Hall, Belfast, by 10 a.m. March 13.

Tenders are required by first post March 18 for six or 12 months' supply of electrical goods to the Cheshire County Asylum, Parkside, Macclesfield. Forms of tender from the Clerk of the asylum.

The directors of the Bedwas Navigation Colliery Co. (Ltd.) Bedwas (Mon.), require tenders by 10 a.m. March 7 for six months' supply of electrical goods, iron and steel castings, ironmongery, &c.

Electrical Accessories.

The Commissioners of H.M. Works, &c., require tenders by 11 a.m. March 4 for six months' supply of electrical accessories. Forms of tender, &c., from the Controller of Supplies, King Charles-street, Westminster, London, S.W.1.

Tramway Trackwork, &c.

Manchester Corporation require tenders by 10 a.m. March 12 for (a) permanent way special track work, and (b) copper rail bonds. Specifications from the Tramways General Manager.

Tramway Stores.

Belfast Tramways and Electricity Committee requires tenders by 10 a.m. March 9 for the supply of electrical accessories, cable, lamps, carbons, &c. Forms of tender from the General Manager.

Bolton.—The Corporation has accepted the following tenders for the supply of plant to Back-o'-th'-Bank electricity works:—

British Thomson-Houston Co., turbo-alternator; Hick, Hargreaves & Co., condensing plant; British Westinghouse Co., switchgear; Babcock & Wilcox, boilers, stokers, &c.; E. Green & Sons, economisers; Ledward & Becket, water-screening plant; Drake & Gorham, one-ton electrical vehicle.

Bradford.—The Corporation has accepted the following tenders:

Brush Electrical Engineering Co., two k.v.a. and one 100 k.v.a. transformers; British Electrical Transformer Co., two 1,000 k.v.a. transformers; Goodall, Clayton & Co., coal-handling plant; British Westinghouse Co., three oil switches; J. Wolstenholme & Son, circulating water pipes; Mather & Platt, two 525 b.h.p. motors for driving circulating water pumps and three centrifugal boiler feed pumps; National Rail & Tramway Appliances Co. and Cole, Marchent & Morley Ltd., tramway brake shoes; J. Brown & Co., Ltd., 400 steel tires.

Cardiff.—The Electricity Committee has accepted the following tenders:—

Laurence, Scott & Co., spare armature for motor and field coils, £116; British Insulated & Helsby Cables, 1,900 yards of cable, £1,400 per mile, and 330 yards of cable, £1,760 per mile; British Electric Transformer Co., three transformers, £355. 15s.; British Thomson-Houston Co., switchgear, £106. 10s.

Glasgow.—The Electricity Committee has accepted the tender of Dick, Kerr & Co. for the supply and erection of a turbine, condensing plant, alternator and transformer at £98,400; and that of the Premier Accumulator Co. for the supply and maintenance of storage batteries at £4,778 for batteries and £289 per annum for maintenance; and that of Edison Accumulators (Ltd.) for a 5-ton electrical motor vehicle at £1,740.

The contract for wiring the exhibition building of the British Industries Fair has been secured by Allan Arthur & Ure at £699. 19s. 6d.

Plymouth.—The Electricity Committee has accepted the tender of the British Electric Transformer Co. for the supply of transformers.

Sheffield.—An order for the supply of coal handling plant at Blackburn Meadows power house has been secured by R. White & Son.

Johannesburg (Transvaal).—The Municipal Council has accepted the tender of Hadfields (Ltd.) for 300 steel tramway tyres at [illegible] 6d. each (total £1,882. 10s.), subject to fluctuations corresponding with the cost of manufacture, &c.

Appointments Vacant.

A chief test room assistant is required for Faraday House electrical testing laboratory. Applications to Dr. A. Russell, Faraday House, Southampton-row, London, W.C. 1. *See advertisement.*

A teacher is required to give lecture and laboratory instruction in the applied electricity classes at the Birmingham Municipal Technical School. Particulars from the Secretary, Suffolk-street, Birmingham. *See advertisement.*

A London supply authority requires a meter test room assistant. Wages 35s., plus 12½ per cent. bonus. *See advertisement.*

A junior shift engineer is required for large power station in the north. *See advertisement.*

A test-room superintendent is required for a Corporation electricity department in the north of England. Salary £225 per annum. *See an advertisement.*

A power-house superintendent is required for a Corporation electricity department in the north of England. Salary £350 per annum.

An engineer is required in the electrical branch of London County Council Tramways depot for testing and repair of switchboard instruments, &c. Salary £255, rising to £300. Applications to the Clerk of the Council, Spring Gardens, S.W.1, by March 8.

Business Items.

The Tramways (Board of Trade) Committee have removed to No. 8, Buckingham-gate, Westminster, London, S.W.1 (Telephone: Victoria 6200; telegrams: Tramboteom Sowest London), and all communications intended for the Committee should in future be addressed to the secretary, Mr. J. N. Wilson, at that address.

Messrs. Ferranti Limited vacated their premises at Central House, Kingsway, London, W.C., and took up temporary quarters at 57, St. John's-square, Clerkenwell-road, London, E.C. 1, on the 22nd inst. Telephone: Holborn 1018, instead of Regent [illegible].

Mr. H. D. Wilkinson, M.I.E.E., electrical inspecting and advising engineer, has removed to 76, Victoria-street, London, S.W. 1.

Liquidations, &c.

Claims against Geo. Edward Hipkins, electrical engineer, 48, Wolverhampton-street, Dudley, are to be sent by March 5 to Mr. A. M. Fairbairn, 1, Priory-street, Dudley.

Meetings of creditors and contributories of the Vaughan Engineering Works (Ltd.), 22, Cross-street, Islington, London, N., will be held at 33, Carey-street, London, W.C. 2, on March 1.

Meetings of creditors and contributories of the Rotherham Electrical Engineering Co. (Ltd.), Tivoli-buildings, Rotherham, will take place to-day (March 1) at the O.R.'s, Figtree-lane, Sheffield.

Companies' Meetings and Reports.

BRITISH L. M. ERICSSON MFG. CO. (LTD.)—The net profit for 1917, after charging £12,588 for depreciation, £8,247 for income tax and £2,500 for debenture interest, amounts to £72,512 8s. 6d., and with £15,072 brought forward the available balance is £87,585. The directors recommend that after payment of the preference dividend (£5,999) the balance be appropriated by paying 8 per cent. (tax free) to the ordinary shareholders (£8,001), placing £11,000 to reserve and £5,000 to a reserve account for extra depreciation, and carrying forward the balance (£57,584 13s. 6d.).

CENTRAL LONDON RAILWAY CO.—Lord George Hamilton stated at the meeting on Friday that the reduction in services of the other transport undertakings, and particularly the omnibuses, had led to an increase in the number of passengers carried by all of the underground railways during the past year, and this Company had participated in that improved business. Expenses had increased in an equal degree, both for material and labour, and the maintenance of the property could only be carried out with the greatest difficulty. The through fare on the Central London Railway was increased at that time from 2d. to 3d., and corresponding changes were made in the fares on the other railways and the omnibuses. If the upward tendency of wages and prices continued further fare increases would undoubtedly have to be made. The work on the Ealing extension had been held up by the war. The parcels delivery service run by the Company had been abandoned. The [illegible] of the Underground Railways [illegible] their operation [illegible].

LANCASHIRE UNITED TRAMWAYS (LTD.)—The report for 1917 states that the result of working of the combined undertakings shows total receipts £121,82[illegible] [illegible]

LIVERPOOL OVERHEAD RAILWAY CO.—The gross revenue receipts for the year 1917 amount to £120,870, and the working expenses (including appropriation to reserve funds) to £89,806, 1s. 6d. The total number of passengers carried was 16,609,337, against 16,074,643 in 1916. The receipts from passenger traffic were £118,376, and miscellaneous receipts £2,494. Deducting working expenses and appropriation to reserve funds (£89,806) and interest on debenture stock (£6,755), and adding balance from 1916 (£6,801), the amount available for dividend is £31,109. 17s. 4d. Interim dividends were paid for the half-year ended June 30 at rate of 5 per cent. per annum on the preference shares, and at the rate of 2½ per cent. per annum on the ordinary shares. Out of the balance (£20,894) the directors recommend the declaration of dividends for the half-year ended Dec. 31 last, at the rates of 5 per cent. per annum on the preference and 4 per cent. per annum (making 3¼ per cent. for the year) on the ordinary shares, leaving £6,929 to be carried forward.

LLANELLY & DISTRICT ELECTRIC LIGHTING & TRACTION CO. (LTD.)—The available profit for 1917, including balance (£1,483) from last account, is £15,185. Loan and debenture interest absorbed £3,383, and after appropriating £860 for debenture stock redemption account, writing £1,100 off machinery, and placing £3,000 to general reserve and renewals account, the available balance is £6,842, out of which has been paid interim dividend on preference shares to June 30, 1917 (£1,656), and the directors now recommend payment of the final dividend on preference shares to Dec. 31, 1917 (£2,117), and a dividend on the ordinary shares of 4 per cent. for the year 1917 (£1,737), leaving to be carried forward £1,331.

LONDON, BRIGHTON & SOUTH COAST RAILWAY.—The accounts for the year ended Dec. 31 show a balance which will enable the declaration of the following dividends: £3 17s. 6d. per cent. for the half-year on the undivided ordinary stock, making £5 per cent. for the year; £3. 15s. per cent. for the half-year on the preferred ordinary stock, making the maximum 6 per cent. for the year; and £4 per cent. for the year on the deferred ordinary stock, leaving about £33,684 to be carried forward.

LONDON ELECTRIC RAILWAY CO.—In moving the adoption of the report at the meeting on Friday, the chairman (Lord Farrer) said that the amount of business done and passengers carried by all of the Underground Railways had largely increased, mainly due to the limitation and alteration of services by the tramways and omnibus undertakings, particularly the latter, and to the abnormal conditions in London. It was extremely difficult to handle the rush of traffic at the times of highest pressure, and improvements of facilities could not be made under present circumstances. The expenses of operation had increased as much as increased traffic. Nearly one-half of the increase in expenses had been due to increased war bonus to the staff. The total advances in wages to employees of the Common Fund Companies during the year 1917 were at the rate of nearly £500,000 per annum. The total sum they were paying for wages at the beginning of the year 1918 had increased at the rate of £500,000 per annum over that of 1917. They must expect, therefore, in the current year a further heavy increase in operating expenses. The cost of fuel and of all of the engineering supplies used in connection with the maintenance of the property had also heavily advanced. The increase in gross receipts, while mainly due to increase of passengers booked, had also been to some extent affected by the increased rates of fare put in effect on both railways and omnibuses in August, 1917. They were not believers in high fares for an urban transportation service, such as that supplied by that group of companies. Present conditions were, however, so abnormal and the purchasing power of money had so fallen that the effect had been, in comparison with prices of all other commodities, that the rates of fare on their railways had actually been reduced, and a partial restoration of the prices became necessary. It was very probable that further increases of fares would have to be made. The capital expenditure during the year amounted to only £9,318, mainly in connection with the completion of the arrangements for through running to Watford. The through service to Watford in connection with the London and North-Western Railway was put into operation on April 16 last, and the results had been even more satisfactory than was anticipated [illegible]

LONDON & SOUTH WESTERN RAILWAY CO. [illegible]

MANSFIELD AND DISTRICT TRAMWAYS CO. [illegible]

METROPOLITAN DISTRICT RAILWAY CO. [illegible]

charge of war profiteering." In general it had been the endeavour of the Underground group of companies to provide an efficient service at low rates of fare, increasing traffic and receipts by offering good facilities rather than by simply increasing rates; but abnormal circumstances required exceptional treatment, and they had raised rates, and would continue to do so, so far as they were able, where the circumstances made this course justifiable and advantageous. Sir Robert Perks criticised the policy of the directors in regard to fares, maintaining that they studied the interests of the Underground Electric Co. as second preference holders, the ordinary proprietors of the District getting no return whatever. They might have paid a dividend on the ordinary stock long ago if they had had the courage to raise the rates to the extent authorised by their statutory powers. The Chairman, in reply, said that the only real danger he saw ahead of their enterprise was that if, with the reputation of having established more or less a monopoly of transportation in London, they made use during war time of the exceptional conditions unduly to raise their rates they would unquestionably lose the goodwill of the public. During the past year they had increased their rates to an extent which would in a full year bring in about £400,000 extra in the combined companies. They did not pay a dividend on the ordinary stock, but the position of the holders of tha tstock was improving year by year, and as half of it was held by the Underground Company they naturally had an interest in obtaining, so far as they legitimately could, a dividend on the stock which they so held.

NATIONAL ELECTRIC SUPPLY CO. (LTD.)—The gross profit for 1917 was £13,825. A sum of £5,000 has been placed to reserve for depreciation of machinery, &c., and a dividend at rate of 3s. 6d. per share (making 6s. per share for the year) has been declared, leaving £160 to be carried forward.

NORTH LONDON RAILWAY CO.—Lord Rathmore, who presided over the annual meeting last week, stated that the receipts in respect of railway working showed an increase over the previous year of £6,231, as against an increase in expenditure of £2,125. The net increase in revenue for the year was £3,304. They were recommending a final dividend of £1 15s. per cent., making £3 15s. per cent. for the year, and they were carrying forward £10,667, compared with £10,302. The interest allowed by Government on capital expended on new works brought them in £4,000 in connection with the capital cost of the electrification of the line. Then, in consequence of not being able to keep up the usual renewals, they had a larger balance at their bankers, and received a larger sum in interest. So far as the North London Railway was concerned, the electrification was practically complete, and they had run a service between Broad-street and Kew and Richmond since April, 1916, but the service had been restricted for want of rolling stock. The increase of 50 per cent. in fares had also militated against them. Some progress had been made during the year towards the completion of the larger scheme, and the electrification of the North-Western line had been completed between Watford and Queen's Park. A morning and evening service has also been run between Watford and Broad-street. [illegible] the electrification between Queen's Park and Chalk Farm [illegible] complete, and there seemed little probability of its being [illegible] before the termination of the war.

TELEGRAPH CONSTRUCTION & MAINTENANCE CO. (LTD.)—The [illegible] 1917 show a net profit of £115,226 10s. 3d. after charging interest on the debentures. With £112,749. 11s. 2d. brought forward [illegible] £227,976 1s. 5d. Deducting interim dividend of 5 per cent. (paid in July last), amounting to £22,410, a sum of £205,566. 1s. 5d. [illegible]. The directors propose to distribute a further dividend of 10 [illegible] together with a bonus of 12s. per share (tax free), absorbing [illegible] £230 [illegible] to add [illegible] £20,000 (making it £155,000), [illegible] £5,000 to the pension fund, leaving £108,336 1s. 5d. to be carried forward. The general business of the company during the [illegible] company's works and steamships [illegible]

TRAMWAYS, LIGHT & POWER CO. (LTD.)—The profits for 1917 were [illegible] the preference dividend the [illegible] £5,000, to reserve, and carry [illegible]

New Companies.

AIRCRAFT & PRODUCTION AUXILIARY ASSOCIATION (LTD.) (149,535.) Reg. Feb. 5. [illegible]

[illegible]

City Notes.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—The following dividends are recommended for the year 1917: On the preference shares, 12s. per share, being at the full rate of 6 per cent. per annum; on the ordinary shares, 16s. per share, being at rate of 8 per cent. per annum. On account of these dividends 6s. per preference share and 6s. per ordinary share was paid in September last.

DIRECT WEST INDIA CABLE CO. (LTD.)—An interim dividend of 6 per cent. per annum (2s. 3d. per share), tax free, on the ordinary shares for the past half-year.

HALIFAX & BERMUDAS CABLE CO. (LTD.)—The directors have declared an interim dividend of 6 per cent. per annum (3s. per share), tax free, on the ordinary shares for the past half-year.

KENSINGTON & KNIGHTSBRIDGE ELECTRIC LIGHTING CO. (LTD.)—The directors recommend a dividend of 4 per cent. on the ordinary shares for the half-year ended Dec. 31, 1917, making, with the interim dividend paid in August last, 7 per cent. for the year.

W. T. HENLEY'S TELEGRAPH WORKS CO. (LTD.)—In a circular issued by the directors it is stated that they are of opinion that the time has arrived for the conversion into a separate organisation of the factory and business of solid and pneumatic motor tyres, which was created a few years ago as a branch of the business. The tyre business was established by means of the capital furnished by undivided profits of the Company, and the business has met with considerable success. It is proposed to form a Tyre Company having a share capital of £200,000, which is approximately the amount of capital that the Company is employing in the tyre business. The whole of the shares in the tyre Company will be held by the Company, who will thus retain the entire control of the business. The directors considered the possibility of distributing among the shareholders by way of bonus the whole or part of the shares in the new Vyre Company, but they came to the conclusion that such a course would not be in the interests of the Company. They have decided to recommend the shareholders to increase the ordinary share capital by £200,000, making it £400,000, and to distribute as a bonus the additional capital of £200,000 amongst the shareholders in proportion to their holdings. The directors also propose to recommend that the ordinary shares of £5 each shall be divided into five shares of £1 each.

TYNESIDE TRAMWAYS & TRAMROADS CO.—The directors have declared a final dividend of 3 per cent. and bonus of 1 per cent., making 6 per cent. for the past year; £3,000 is being added to reserves, and £1,312 carried forward.

The Round Table.

By "kVA."

Engineering gave the world male and female threads; the war has given us male and female conductors. C.M.A., please note!

* * *

Thus the "Daily Graphic" under headline "Troubles on the Tubes":

Three slight mishaps occurred on the London tube railways yesterday morning when people were proceeding to business. At Paddington, on the Bakerloo Railway, an electrical fusing caused a delay, while at Warwick Avenue station one train collided with the rear of another, with the result that the driver and an electrician were injured about the legs. Sympathetic action following the first fusing accounted for the mishaps in the other two cases, the electrical arrangements of the tubes being all inter-related.

"Sympathetic action" and "inter-related" must be new technical terms, but for the lay press it is not a bad attempt!

* * *

Thirty-Seven Years Ago.

[From The Electrician, Feb. 26, 1881.]

Street Fire Alarm Boxes. It is suggested that fuller and more conspicuous instructions should be issued as regards the proper mode of giving the alarm in case of fire.

An Enterprising Native. The Austrian papers state that an Indian prince was so struck with the accounts he read of the electric railway exhibited at the Austrian Industrial Exhibition that he has purchased it, and ordered it to be sent to India. He has also secured the services of the engineer in charge.

Photophonic. "Theoretically a telephone with a blackened disc diaphragm enclosed in a high vacuum and connected with an external telephone should serve as a receiver; and the writer of these lines has already attempted to devise a thermo-electric receiver for reproducing sounds from invisible calorific rays." S. R. F. in "Nature."

A Yankee Story. An American paper says: "One of the electrical curiosities manufactured by Mr. Leo Daft in the course of his experiments was an electric lamp so small that it could be carried in the vest pocket, or held lighted *in one's mouth* for an hour or two without injury. The light was so brilliant that it could be seen through the solid tissues of the face, and be used to illuminate them for medical purposes."

THE ELECTRICIAN:

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CONTENTS.

Notes.

Financial Risks of Large Stocks.

We are glad to note that the Ministry of Reconstruction has appointed a Committee to consider what safeguards should be taken to avoid serious financial loss as a result of possible depreciation of stocks after the war. There is no doubt that the amount of capital at present involved in stocks by the various manufacturing companies [illegible]. The price of raw material [illegible] higher and higher, and consequently the available working capital, in so far as it is utilised for stocks, [illegible] smaller and smaller quantities. Thus it is found necessary for further capital to be invested in stocks if the turnover is to be maintained. [illegible] after the war there will undoubtedly be a more or less rapid decline in sale prices, and if large stocks are held this will necessarily entail a considerable loss to the manufacturer. It is difficult to know how this situation is to be met. One method would be to regulate prices for a certain period until stocks were worked off and the price of raw materials became more or less normal. This, however, would be a very difficult matter. Another method would be to give State aid to counteract losses of this kind. This, no doubt, would be far less complicated, but it is open to certain objections. In any case, the subject is eminently one which will require most careful consideration, for if there is a holding back in the purchase of stocks then the productiveness of the country after the war will certainly suffer. The subject is one which has a very direct interest for several Government Departments, such, for example, as the Committee on the Provision of Financial Facilities for Trade after the War. The Committee, therefore, has been so constituted as to ensure co-operation with other Departments, including [illegible], the Board of Inland Revenue, and the Board of Trade. Those who are interested in the matter should communicate with the Ministry of Reconstruction.

Labour-Aiding Appliances in Steel Works.

According to Mr. S. T. Wellman, during 1916 a weight of 20 million tons of pig iron and scrap was handled by the open-hearth charging machines and lifting magnets at least once, the bulk of it twice, and a great deal of it three times. By the use of the electrically-driven open-hearth charging machine, the direct saving in labour was estimated about 10 years ago by a prominent user in America at approximately 12·5d. per ton. The indirect saving is very much higher, and the same authority estimated this at not less than 25d. per ton. On an output of 20 million tons, and taking no account of the present day high wages, the saving in handling of the material charged into the open hearth furnace amounts to several millions sterling. It is said that the saving in labour by the use of the lifting magnet in the United States, at the rate pig iron and scrap are being handled to-day, is not less than £[illegible] per annum. From a recent issue of the "Journal" of the Cleveland Engineering Society, it appears that at the No. 1 plant of the Carnegie Steel Co., Pittsburgh, the two charging machines which serve the seven 40 ton furnaces handled 1·2 million tons from 1897 to 1917. The twelve 40 ton and four [illegible] ton furnaces in the No. 2 open-hearth plant are served by four charging machines, which have handled during the years [illegible] to 1917 approximately 9·5 million tons. In this case the weight of molten metal passing through the furnaces is not included. Mr. Wellman estimates that the saving in labour charges in American steelworks by the use of the charging machine and lifting magnet amounts to nearly 20 million pounds sterling. Further, he states that [illegible] open-hearth plant [illegible] the world to-day is equipped with these [illegible], and they are [illegible] part of the equipment of the furnace [illegible].

The Relation of Quantity Production to Cost

While there is a general recognition that special work is necessarily more expensive than producing standard articles in large quantities, one rarely sees detailed figures presented in support of this view. The matter is treated with exceptional completeness in an article by Mr. A. G. [illegible] in "Industrial Management." Special work, he remarks, is inevitably "inefficient work," in the sense that even skilled workers become relatively unskilful when employed on an unfamiliar operation. Apart from this, such special operations, besides being costly in themselves, add more or less to the cost of all standard apparatus going through the shop by disturbing the routine, and this must also be taken into account in fixing the price of an article. To illustrate this point he considers in detail the production of shafts of specified dimensions in lots of [illegible] 10, 25, 50 and 100, tracing each necessary operation and checking the cost in each case. The following results are illuminating:—

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		

It is also shown that the [illegible] varies from 10·[illegible] per [illegible]

In the course of the article the author also discusses various arrangements of tools and their effect upon cost and efficiency of production, and shows that the best manufacturing method depends essentially on the size of the lots in which the shafts are produced. Even this relatively simple operation is thus in reality quite a complicated problem. It is to exhaustive analyses of this kind that we must look in order to reduce the manufacturing costs of large operations.

Methods of Concentrating and Directing Light.

THE Paper read by Lieut.-Commander HAYDN T. HARRISON before the Illuminating Engineering Society on February 26th raised a number of interesting points. It would doubtless have been even more informative if the author had felt free to refer to aspects of the subject relating more closely to his present work. Some data were presented illustrating the magnifying power attainable from reflectors embracing 90, 180 and 270 degrees of luminous flux. In some cases a multiplying power of 2,000 can be attained even with concentrated filament incandescent lamps, and there have, no doubt, been considerable advances in this direction since the outbreak of war. While the military and naval applications of such units cannot now be discussed, they have already proved to have many useful industrial applications—for example, in the "flood lighting" which has been so largely developed in the United States as an aid in guarding important bridges, munition works, &c. The author speculated on the possibility that highly concentrated beams may even come into use for some forms of interior lighting, the idea being that such beams could be directed on to a white surface of prescribed form and area, which in turn became a luminous source. In this way, possibly, the advantages of purely indirect lighting might be obtained without the "flatness" which is apt to characterise this system. Certainly there are interesting possibilities in this direction, especially if the co-operation of the architect could be enlisted; but we imagine it would find application chiefly in large interiors, and where spectacular effects are desired, and that it is hardly likely to become a regular feature in ordinary domestic lighting.

British Association.—It is announced that owing to war conditions, the annual meeting of the British Association will not be held. Presumably, reports of committees will be [illegible] by the Council as they were last year.

Industrial Reconstruction Council.—The Industrial Reconstruction Council is holding a meeting at the Town Hall, Manchester, on Wednesday, March 13th, at 3 p.m., under the [illegible] of the Lord Mayor. Mr. G. H. Roberts, Minister of [illegible], and Sir William McCormick, Department of Scientific and Industrial Research, will be the leading speakers. This is the first of a series of public [illegible] meetings in all the great [illegible] of the country arranged by the Industrial Reconstruction Council with the object of [illegible] national [illegible] the immediate [illegible]. Applications for tickets should be made to the Secretary, The Industrial Reconstruction Council, [illegible] London, E.C. 4.

The Transparency of the Lower Atmosphere to Ultra-Violet Energy.—[illegible] the Royal Society, by the [illegible] that the lower atmosphere is relatively [illegible] to ultra-violet rays. [illegible] can be detected at a distance of [illegible]. [illegible] the ground [illegible] transparent than the upper air and [illegible] in that region [illegible] there must be [illegible] in the upper regions of the atmosphere than in the lower. Probably scattering by small particles also plays some part in reducing the transmission of ultra-violet energy and this makes exact quantitative determinations of the amount of ozone difficult.

Some Problems in the Theory of Radiation.—A Paper read by Prof. Arthur Schuster before the Royal Society deals with the oscillatory energy taken up by a simple resonator under the action of white light, and the translatory energy imparted to a molecule by radiation. The first problem has been treated by Planck. It is solved here in a very simple manner, and the method used, when applied to the second problem, leads to the important re ult that a molecule at rest, within an enclosure of uniform temperature, will, while taking up oscillatory energy, be set in motion with an acceleration that will increase its speed until the average energy reaches a definite value. If the Rayleigh-Jeans laws of radiation be assumed to hold, the ultimate average energy due to radiation alone is two-thirds of that derived from the kinetic theory of gases.

Transportation Deficiencies.—A note prepared by Mr. A. J. Marshall, secretary of the Electri al Vehicle Section of the National Electric Light Association, refers to some elements of waste in transport, the avoidance of duplication and undue delays. The general conveyance by railroad and steamship involves the goods passing through a number of successive departments. The actual cost of transporting a ton of freight over the 90 miles between New York and Philadelphia is estimated at 27 cents, as contrasted with the terminal charges amounting to 3·65 dollars. Some scheme might be worked out whereby railroads, either by themselves or operating through a co-operative track concern, could handle freight directly from shipper to consignee. The whole question is receiving the attention of the Commercial Economy Board of the Council of National Defence (Washington).

Stellite as a Substitute for Platinum.—A Paper by Mr. E. Haynes in the "Proceedings" of the American Chemical Society refers to the present scarcity of platinum and to possible substitutes. An alloy of gold and palladium is probably the best alternative material, but the cost is high, although, bulk for bulk, only half that of platinum. The alloy of nickel with chromium, the silicon-iron alloys, and pure quartz have also given satisfactory results for some purposes. In many cases, for example in jewellery, stellite can with advantage be substituted for platinum. The malleable alloys are composed of cobalt and chromium. They resist nitric acid completely, are slowly attacked by hydrochloric, sulphuric and hydrofluoric acid but are nearly immune to all chemical combinations and the fruit acids. Evaporating dishes of this material take a bright polish and enable substances to be evaporated to complete dryness, without any danger of cracking.

Unbreakable Pipes.—The "Electrical Review and Western Electrician" describes a form of steel pipe now being made by the National Tube Co. in Pittsburg, which is stated to be practically unbreakable. When subjected to very severe stress it crumples, but does not actually fracture. A case illustrating these properties recently occurred in an oil well where 170 quarts of nitro-glycerine were placed in the well and exploded with the intention of "shooting" the well. The telescope pipe remained in the well during the process, was reduced in length from 18 to 6 ft., and was badly crumpled by the force of the explosion, but did not break. Other cases of long lengths of steel let fall from heights of several hundred feet are also mentioned. Here again the tubes were bent and telescoped but there was no cracking. It is expected that this form of tube will be very useful for work in which severe stresses are possible, and where it is of importance that the pipe should not fracture.

Institute of Chemistry.—At the 40th annual general meeting of the Institute of Chemistry on March 1st Sir James Dobbie, the retiring President, said that the past three years had afforded unusual opportunities for demonstrating the utility of the Institute. Every public department and branch of the forces that required the aid of the chemist had made use of its

services. It had introduced many candidates for commissions, and provided many chemists for Government factories and laboratories engaged in war work. Furthermore, the Institute had been unremitting in its efforts to ensure to chemists a supply of pure reagents, glass and porcelain, and, with the aid of the Department of Scientific and Industrial Research, researches bearing on nearly every branch of the glass industry had been carried out. The Council had been devoting attention to the revision of regulations affecting the admission to membership of the Institute and the more complete organisation of British professional chemists. It is understood that an extraordinary general meeting of the Institute will be held shortly with a view to the discussion of these regulations.

Dielectric Strength of Vulcanised Fibre.—Vulcanised fibre is such a widely used and convenient insulating material that information on its dielectric strength is welcome. We observe that according to some tests undertaken in the United States by Mr. William Eves, and summarised in the "Electrical World," the relation between rupturing voltage and thickness of material is somewhat complex. As is well known, the relation is not proportional. It appears, moreover, that if a number of thin slabs with intervening layers of metal are built up to form one piece, the diminution in relative resistance power with increasing thickness is much less marked. Apparently the forced distribution of parallel equipotential surfaces throughout the mass of the material enables the slab to resist the stresses better, even though it is evident that the rupture of any component slab will immediately [illegible] it throughout owing to the presence of the tinfoil. There are, of course, various factors such as the effect of moisture, of temperature, &c., which give rise to variations in the behaviour of different specimens. Even so, it is remarked, it should not be impossible to draw up a broad specification as regards dielectric strength for materials of this class.

A Novel High-Pressure Steam Plant.—The "Electrical World" describes the design and construction of what is stated to be the first central generating station on the United States to operate at 300 lb. steam pressure. The plant in question feeds energy into the transmission system of the Public Service Co. of Northern Illinois, and is one of a number of plants now serving 15 counties. It is anticipated that ultimately its present capacity of 10,000 kw. will be increased to 60,000. It is as yet early to predict the [illegible] from the higher steam pressure used. It appears probable, however, that the over-all boiler efficiency will be [illegible] per cent., a gain of about 5 per cent. over what is stated to be the best existing practice in the United States. In the turbine the additional 100 lb. pressure may make possible a further gain of 6-7 per cent., giving a steam consumption which will compare favourably with that of the largest units now in service. It is regarded as not unreasonable to anticipate that the new plant will produce one kilowatt-hour per 18,000 B.Th.U. Against the increased efficiency is to be set the somewhat higher initial cost of the plant which may be 20 per cent. above the corresponding cost for plant designed for 200 lb. pressure, though in the case of turbines the increase will probably be less. Another interesting feature of this new plant is the high operating steam temperature attained in the neighbourhood of [illegible]. There appears at present to be some difference of opinion as to the choice of pressure or superheat in making up the total steam temperature. Further experience of the plant will be awaited with interest.

Obituary.

Lady Wason.—We regret to record the death, which occurred on the 2nd inst., of [illegible] the late Sir [illegible] Wason, [illegible]

Deaths on Active Service.—The following deaths on active service are reported:—

Pte. W. [illegible] (R.N.D.), formerly employed in the [illegible] [illegible] [illegible], on Dec. 31 [illegible].

Pte. [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] hospital.

Lance-Corp. Lovelady, R.E., an employee of Haslingden electricity department, is reported to have died in action.

Pte. Fred. Walton (E. Lancs. Regt.), a Blackburn tramway employee, has died of wounds.

Personal.

War Honours.—The following honours have been conferred:—

Corp. A. Call, formerly a Cardiff tramway employee, has been awarded the Military Medal.

Bombr. S. J. Scarfe (West Lancs. R.F.A.), who has also been awarded the Military Medal, was formerly employed on the Preston Corporation tramways.

Lance-Corp. D. Phillips (Welsh Regt.), formerly a motorman in the employ of the [illegible] Tramways Co., has been awarded the Military Medal.

Arrangements for the Week.

FRIDAY, March 8th (to-day).

Physical Society.

5 p.m. At the Imperial College of Science, Imperial Institute-road, South Kensington, London, S.W. Papers on "The Asymmetrical Distribution of Corpuscular Radiation Produced by X Rays," by Mr. E. A. Owen, B.A., and "On [illegible] Internal Combustion Engine Cycles and their [illegible]," by Prof. C. H. Lees, F.R.S.

Royal Institution.

5.30 p.m. At Albemarle-street, Piccadilly, London, W. Discourse on "Vibrations: Mechanical, Musical and Electrical," by Prof. E. H. Barton, F.R.S.

SATURDAY, March 9th.

Royal Institution.

3 p.m. At Albemarle-street, Piccadilly, London, W. Lecture on "Problems in Atomic Structure," by Prof. Sir J. J. Thomson, P.R.S. (Lecture IV.)

Association of Mining Electrical Engineers.

3.30 p.m. At the Royal Technical College, George-street, Glasgow. Paper on "Construction of Exhaust Steam and its Utilisation," by Mr. J. Watson.

Birmingham and District Electric Club.

7 p.m. At the Swan Hotel, New-street, Birmingham. Discussion on "The Demand System," opened by Mr. J. M. [illegible].

MONDAY, March 11th.

Institution of Electrical Engineers.—Western Local Section.

7 p.m. At the Merchant Venturers' Technical College, Bristol. Paper on "[illegible] of Large Amounts of Power," by Mr. E. B. Wedmore.

TUESDAY, March 12th.

Institution of Civil Engineers.

5.30 p.m. At Great George-street, Westminster, London, S.W. [illegible] [illegible] Water-power [illegible] by Prof. [illegible] [illegible].

Institution of Electrical Engineers.—Manchester Local Section.

7 p.m. At the [illegible] [illegible] [illegible] Manchester. Paper on "[illegible] of Large Amounts of Power," by Mr. E. B. Wedmore.

Institution of Electrical Engineers.—Scottish Local Section.

7 p.m. At [illegible] [illegible] Hotel, Edinburgh. Paper on "Electrical Signalling and Control on Railways," by Mr. [illegible] M. Jacob.

Institution of Electrical Engineers.—Yorkshire Local Section.

7 p.m. At the Philosophical Hall, Leeds. Paper on "The Mechanical Design and Specification of the Turbo-Alternator Rotor," by Dr. S. F. Barclay.

WEDNESDAY, March 13th.

Association of Engineers-in-Charge.

8 p.m. At St. Bride Institute, Bride-lane, Fleet-street, London, E.C. Paper on "The Superintendence of an Engineering Plant at a Large Hotel," by Mr. A. H. Barker Wills.

Institute of Metals.

8 p.m. At the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W. [illegible] [illegible] by Prof. H. C. H. Carpenter.

THURSDAY, March 14th.

Institute of Metals.

[illegible] p.m. At the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W. [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] by Mr. O. W. Ellis, M.Sc.

[illegible]

The Control of Large Amounts of Power.*

By E. B. WEDMORE.

Summary.—The author considers in detail where reactance should be inserted so as to limit disturbances on large networks and thus to confine disturbing forces within limits to which we are already accustomed.

The increasing use of electrical energy and its economical production require the use of larger generating stations and the linking together of existing plants, these extensions involve something more than the use of larger units and the adding of unit to unit. New conditions are reached. Factors which were negligible in smaller aggregations of plant become serious and limiting features. The forces accompanying a disturbance are increased. The limiting features are to be looked for not only in the generating station but in the distributing system. A striking characteristic of developments now in prospect in the principal industrial areas is the increased concentration of large amounts of power in small areas.

One may double the size of a generating station with advantages in economy and without excessive expenditure on switchgear to take care of the conditions in the station itself; but for every machine, switch, and conductor in the main station there are large numbers of smaller machines, switches, and conductors in the distribution system, and if these also are subjected to increased forces a very heavy expenditure may be necessary to ensure satisfactory service.

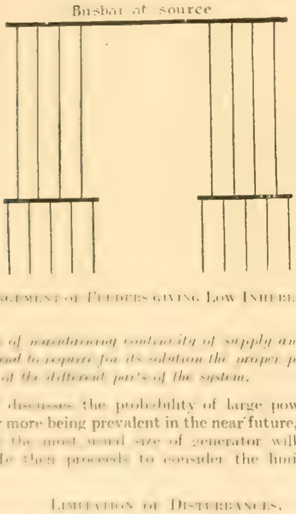


FIG. 1.—ARRANGEMENT OF FEEDERS GIVING LOW INHERENT IMPEDANCE.

The problem of maintaining continuity of supply and of protecting the plant is found to require for its solution the proper proportioning of the impedances of the different parts of the system.

The author discusses the probability of large power stations of 100,000 kw. or more being prevalent in the near future, and expresses [illegible] that the most usual size of generator will be 20,000 to 30,000 kw. He then proceeds to consider the limitation of disturbances.

LIMITATION OF DISTURBANCES.

[illegible] maintenance of voltage at all parts of the system and [illegible] the disturbance of running machinery. [illegible] the power which can be concentrated [illegible] calling for [illegible] individual pieces of apparatus.

[illegible]

Limitation [illegible] Employment of Reactance.—[illegible]

[illegible] part of the [illegible] the total load [illegible]

* [illegible]

Wherever employed the reactance limits the disturbance in all parts of the system beyond it and tends to isolate the disturbance from all parts nearer to the source of supply.

In discussing the use of reactance it is found convenient to rate the reactance in terms of the percentage reactive voltage-drop it will give on the full-load rating of the part of the plant with which it is associated.

Limitation by Generator Reactance.—Reactance may be employed at the source, viz., in or with the generators themselves, where it need not interfere with the losses. It is anticipated that this method will be carried further than it has been hitherto.

Most generating sets will be used in conjunction with step-up transformers, the machine and transformer forming one unit. In this case the transformer reactance will be additional to that in the machine and will add, say, 4 per cent., but there is no reason why the transformer should not be designed to give more than this, and at a lower cost than that of employing a separate external reactance.

Reactance in this position serves only to reduce the magnitude of the short-circuit currents. In order to maintain the supply voltage, we must employ a proper ratio of busbar reactance to generator reactance and of feeder reactance to generator reactance; and as it will be found that the amount of busbar or feeder reactance which can be used is limited on account of interference with regulation, it follows that the generator reactance is also limited if a proper ratio is to be maintained between the two.

Limitation by Feeder Reactance.—Resistance and reactance in an individul feeder anywhere in the system helps to maintain the voltage on all parts of the system connected on the source side of the impedance, and assists in limiting the magnitude of the fault current at any point beyond the impedance, but the voltage at all points beyond the impedance is equally disturbed.

Inherent reactance may be utilised in such a way as to serve all these three functions, as may be seen by comparing Figs. 1 and 2. Fig. 1 shows power fed through eight feeders to two substations and distributed through 10 outgoing feeders. In Fig. 2 the same eight feeders are divided into four groups of two and there are 16 outgoing cables of smaller section. It is clear that in the latter diagram we have not only increased the number of sections and thereby reduced the area affected by a given fault, but we have doubled the impedance between each substation and the main station, and greatly increased also the impedance in the outgoing feeders. Thus by separation of feeders we can introduce more impedance both near the source and near the parts to be protected. At the same time

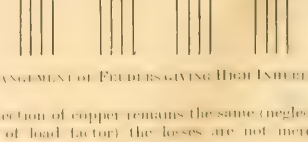


FIG. 2.—ARRANGEMENT OF FEEDERS GIVING HIGH INHERENT IMPEDANCE.

if the total section of copper remains the same (neglecting the slight impairment of load factor) the losses are not increased and the regulation is unaffected.

In three systems where step-up and step-down transformers are employed, these introduce further inherent reactances, so that in practice, except where there is considerable concentration of load, the use of artificial feeder reactance should be avoidable; and where it is required, it should be put as near as possible to the point to be protected.

The use of series reactance interferes with the regulation to an extent which may be quite serious for lighting unless the energy is transformed to continuous current.

In a case where the inherent reactance limits the kilovolt-amperes on short circuit to 100,000 to 150,000 k.v.a., for example, this figure

can be reduced to 20,000 k.v.a., or well within reasonable limits for consumers' premises, by the employment of series feeder reactance introducing potential drops as follows on a load circuit of 80 per cent. power factor:—

Load.	Potential drop.
1,000 k.v.a.	$2\frac{1}{2}$ per cent.
2,000 ..	5 ..
5,000 ..	$12\frac{1}{2}$ ..

We shall see, however, that much better conditions can be obtained by a proper use of reactance at the generating station, in the machines, busbars, or feeders as required, to reduce the short-circuit currents at the substations.

Limitation of Voltage Disturbance.—We may consider three typical cases, viz.:

(*a*) Distribution for lighting through transformers.
(*b*) Distribution through induction-motor-driven sets.
(*c*) Distribution through rotary converters and synchronous motors.

(*a*) Where the distribution is by transformer the voltage must necessarily be disturbed to an extent visibly affecting the lighting on sections adjacent to the faulty one, but the disturbance will last only until the protective gear has isolated the fault.

(*b*) *In the case of induction motors a heavy fall of voltage is not serious so long as the fault is cleared in about two seconds or less*, which lies well within the capacity of modern protective apparatus.

(*c*) In the case of rotary converters and synchronous motors, we have only approximate data, but can form a good general idea of what is required. A rotary converter running fully loaded will not be pulled up if the voltage falls to one-third or one-quarter of normal, but the machine is sensitive to sudden changes of phase angle. The reactance which limits the voltage drop also reduces the phase-swinging. Faults remote from the source present no difficulty, but we cannot employ sufficient reactance in outgoing feeders in the generating station to prevent the voltage being pulled down on a fault. *It is likely, however, that the machines on sound circuits will not be disturbed if the voltage does not drop below 50 per cent. of normal at the source.* At the first instance the drop will be much less than this, but the generators will be quickly demagnetised and the voltage will approach the limit in less than a second.

If the generators have a short-circuit reactance of 15 per cent. and are furnished with potential regulators, it is likely that they would require a feeder reactance of 33 per cent. based on the generator rating to meet this condition. If, now, there are 10 feeders (and about the same proportion of spare feeders and spare machines), this requires at full load a feeder reactance of only 3.3 per cent. based on the feeder rating. At times of light load, however, when, say, there is only one machine running, the feeder reactance would have to be proportionally higher, so that it is clearly not possible fully to protect the rotary converters all the time, even with reactances in each outgoing feeder.

Limitation by Busbar Reactance.—The author then considers the use of busbar reactances, and shows, for example, that with five busbar sections, with generator reactance of 17 per cent. and busbar reactance of 6 per cent., it is possible to keep the maximum value of the short-circuit k.v.a. down to three times the plant capacity, instead of 10 times the plant capacity, a common figure at the present day; *that is, we could build a 100,000 k.v.a. plant in which the conditions will be no more severe than in a present-day 35,000 k.v.a. plant.*

The number and size of machines should preferably be determined so that with adequate provision for spares the machine capacity will be divided equally between the sections, the number of sections being such as to give the required degree of protection whilst suiting the local conditions. It is assumed that there will generally be two machines in excess of the total corresponding to the maximum output.

Transfer of Power.—We have to transfer power from section to section for purposes of economy, and the transfer may amount to 20 to 70 per cent. of the capacity of a section. The transfer may take place in either direction. For it to take place at all it is necessary to set up a difference of potential between sections, whereas working conditions require that the sections shall be at substantially the same voltage.

The transfer of the energy component of current through the reactance will not require a potential difference greater than is necessary to overcome the ohmic resistance, and this will be some small fraction of 1 per cent., perhaps [illegible], with 10 per cent. reactance between sections. The transfer of magnetising current, however, will require a considerable potential difference, and this will be in fact the reactance drop at the current in question, and this proves to be the limiting factor.

The obvious solution appears to be to transfer the load at a higher power factor and to make up the shortage of magnetising current by supplying it from the machine or machines tied to the section in question.

In pushing the use of reactances up to the limit it is necessary to utilise this method of maintaining the voltage, but it is not one which should be used under daily working conditions. It involves underloading one or more of the machines, extra care in running adjustments, and in case a fault occurs on the section receiving current, the voltage drop will be greater.

It will be found that ample protection can be obtained by the use of generator and busbar reactances under normal working conditions without resorting to transference at a power factor above that of the load; but this method can be advantageously resorted to under emergency conditions.

THE INTERCONNECTION OF STATIONS.

Conditions Affecting Parallel Running.—The question now arises. How will the employment of reactances between sections affect parallel running? This becomes particularly important in the case of stations remote from one another tied together for economy. Such ties may not be of large cross-section and may therefore introduce considerable resistance.

The theoretical treatment of this and similar cases has not been entirely satisfactory, but we may recognise that there are lower and upper limits to the reactance between which we can get satisfactory operation. *It has been found that it is not generally practicable to obtain stable running conditions when the [illegible] of the total*

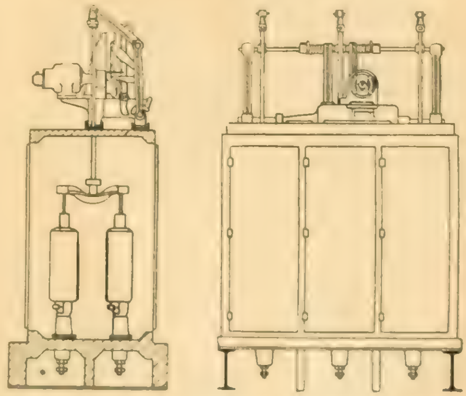


FIG. 3.—OIL SWITCH SHOWING GOOD INSULATION TO EARTH AND BETWEEN PHASES.

reactance [illegible] between the machines is less than [illegible] the resistance. This necessitates the employment of external reactance in series with long underground tie cables of small cross-section. Where, however, there are step-up and step-down transformers in the circuit there will be ample reactance.

There must be an upper limit also, and this is not easy to determine. It is evident that if two systems are running steadily at about the same frequency and voltage, a very small transfer of energy and magnetising current passing through a high reactance will keep the two systems in synchronism. If one system is suddenly disturbed it will get out of phase with the other, and the small currents transferred will be insufficient to disturb the second system and will eventually bring the systems into synchronism after conditions have become normal and steady. [illegible] parallel running without trouble but without utility.

If now, we reduce the reactance [illegible] systems [illegible]. The [illegible] reactance of [illegible] per cent. [illegible] 10 per cent. [illegible]

Limiting Effect of Fault Resistance.

One must not expect to find any protection from internal resistance of faults, except when the fault is to earth through a poor earth connection or includes a long open arc.

As faults to earth can be positively limited by the employment of resistances in the earth connection, it is only faults between phases that present a serious problem. The likelihood of such faults occurring can be greatly minimised by appropriate design. A good example is to be found in a large oil switch constructed as in Fig. 3 with insulated tanks, those on each pole being enclosed in a stone or brick cell.

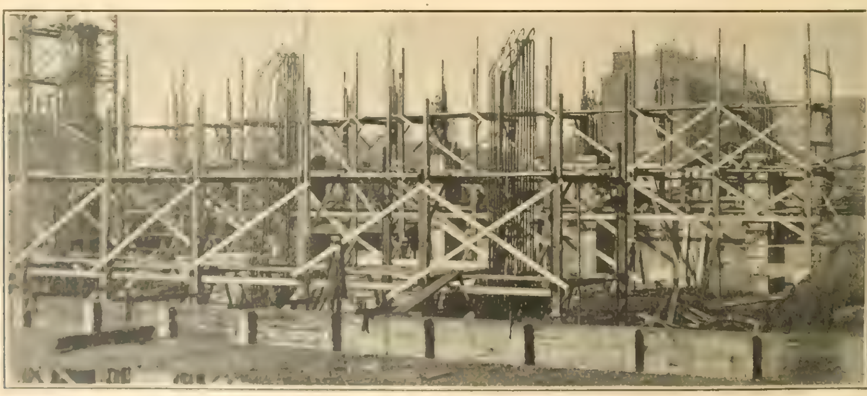
Conductors surrounded with insulating material may be further separated by earthed metal barriers so arranged that a fault to earth is confined to the phase on which it occurs. A good example is found in a machine in which the conductors throughout their length, including the end turns, are covered with insulating material and separated by earthed metal parts with which they are in intimate contact. A breakdown on such a machine must arise as a fault to earth, and is localised by the formation of a good enclosed conducting path to earth. The risk of open arcing is minimised, and consequently the risk of the fault spreading to other phases and consuming the whole machine.

The advantages obtained by the use of selective protective apparatus on large distributing systems are now generally recognised. The use of such apparatus throws a severe duty on the switchgear, as switches have to clear faults whilst the currents are in the neighbourhood of maximum value, and the onus of clearing each particular fault is thrown on the individual switch or switches nearest to it. For these reasons it is necessary to employ with the selective protective apparatus a system of stand-by protective apparatus which comes into use in case of failure of switchgear or selective apparatus. This takes the form of a system of fixed time-limit relays with graded settings which will come into operation only after failure in the first line of defence. A plant so protected will be as well off even on failure of the selective apparatus or distribution switchgear, as plants have been in the past which were protected solely by the apparatus now used as a stand-by.

The Paper is followed by lengthy appendixes dealing with the rupturing capacity of oil switches, rating of reactances, arrangement of busbars, current limiting by busbar reactance, transfer of load through reactances, heating and stresses due to heavy currents.

Electricity Supply in Glasgow.

Mr. W. W. Lackie, chief engineer and manager of Glasgow Corporation electricity department, delivered an interesting address to the Glasgow City Business Club recently. Having described the existing generating stations in Glasgow, he proceeded to show the influence of condensing water on coal consumption. The loss in vacuum, resulting from the high temperature of the water used for condensing purposes, he said, meant a loss of at least 30,000 tons of coal per annum at Port Dundas station alone, and a similar state of affairs prevailed at St. Andrew's Cross station. With the ample supply of condensing water which would be available at the new power station, there would be a money saving of at least £45,000 per annum.



The Foundations of the New Power Station.

[illegible]

[illegible]

boilers, the boiler house area being about 3 acres. The first section of the turbine room would be 250 ft. long by 75 ft. broad. A separate building will contain transformers and switchgear. Coal having been delivered by rail will be tipped direct from the wagon into a hopper, and be crushed if necessary. Passing thence to a conveyor, the fuel will be elevated to a distributing hopper. From the latter it will be taken by another conveyor either direct to the boiler house or to any part of the coal store. The boiler pressure will be 275 lb. per square inch. Accurate measuring instruments to show draught, temperature of steam and water, amount of steam, &c., will enable the boiler house engineer to know the efficiency of the plant under his charge. The boiler house is to be a three-story building. In the basement electric wagons will be run to catch the ashes direct from the boilers, and there will also be forced draught fans in the basement. The first floor will contain the boilers proper, and the upper floor will house the economisers, induced draught fans and coal conveyor.

The turbine room will consist of two floors, the ground floor containing condensers, circulating and air pumps and other auxiliaries, and the upper floor containing turbines and alternators. The first two sets will be 25,000 H.P. each. The use of these large sets will mean a saving of at least 20 per cent. as compared with what is obtainable with the existing plant. The energy will be generated at 6,500 volts and transformed to 20,000 volts for distribution. The 20,000 volt [illegible] the first of its kind, and will cost £70,000.

The site extends to 46 acres, and the margin of ground available might be used for treating coal prior to burning it in the boilers, or for electro-chemical or electro-metallurgical processes.

Notes on the Design of Electromagnetic Machines.*

PART III.

DESIGN OF AN ALTERNATING-CURRENT TURBO-GENERATOR.

By STANLEY PARKER SMITH, D.Sc.

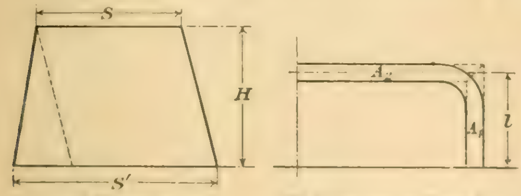
(Continued from page 727.)

Summary.—In Part I. of the article the author deals with some of the main principles underlying the design of alternating-current generators. In Part II. these principles are applied to the design of a low-speed, three-phase alternator, giving 750 kw. at 2,200 volts when running at a speed of 250 revs. per min. In Part III. a three-phase turbo-alternator is designed to give 2,000 kw. at 3,000 revs. per min. at a line pressure of 500 volts, and the mechanical stresses in the rotor are discussed.

7. MECHANICAL DESIGN OF ROTOR.†

Careful attention must be given to the mechanical design of turbine-driven alternators, as the conditions of service render this type of machine liable to very heavy stresses, due both to mechanical and electrical causes. In this section it is proposed to calculate from first principles the chief mechanical stresses that occur in the rotating parts.

The difficulties encountered in turbo-rotor design are such that both mechanical and electrical designers must be ready to make reasonable compromises if the best result is to be obtained. In the case of the rotor teeth especially it is often necessary for the electrical designer to modify his design to meet the mechanical designer's requirements, whilst the latter must assist the former by providing efficient ventilation.



(A) TRAPEZIUM. (B) OVERHANG OF ROTOR COIL.

FIG. 26.

As far as possible, the mechanical designer must be given a free hand in the choice of materials used for the rotating parts, for it is essential that only materials of the best quality are used, particularly for the parts where the factor of safety is low. It follows therefore that reliable data about the ultimate and working stresses should be available.

Usually the section where the stress has to be calculated is a parallelogram, triangle or trapezium, so that the position of the centre of gravity is easily found. In the case of the trapezium, the centre of gravity lies on a line joining the centre of the base to the centre of the opposite side and at a height above the base equal to $\frac{H(2S+S')}{3(S+S')}$ (see Fig. 26A), as can be shown by dividing the trapezium into a parallelogram and a triangle. The centre of gravity of the overhang copper lies on the centre line of the [illegible] at a distance from the centre equal to $\frac{l(A_1 + 2A_2)}{2(A_1 + A_2)}$ where A_1 and A_2 are the areas of the parts shown in Fig. 26B and the overhang is taken as rectangular.

The *centrifugal force* F is calculated from the formula

$$F = \omega^2 W R / g \text{ kg.}$$

where $\omega = 2\pi n$, n being the speed in revolutions per second,

W = weight in kg. of the part for which F is being calculated,

R = radius in cm. of the centre of gravity of this part.

In the case of an alternator [illegible] $F = [illegible]$ WR kg. [illegible]

(a) *Calculation of Stresses in Teeth and Wedges.*—The centrifugal forces of the various parts acting on a tooth and a wedge are shown in the following table, which is self-explanatory. The sections and dimensions are shown in Fig. 18A, whilst the length $L = 100$ cm. for each item.

Item.	Part.	Area in cm².	Volume. in cm³.	Density.	Weight W in kg.	Radius R in cm.	C.F. in kg. F = 1001 WR.
I.	Tooth $A-C$	33·67	3,367	7·8	26·2	25·82	68,000
II.	Tooth $A-D$	42·05	4,205	7·8	32·8	24·38	80,000
III.	Wedge	5·1	510	8·9	4·54	29·7	13,500
IV.	Copper	18·3	1,830	8·9	16·3	24·5	40,000
V.	Insulation...	5·9	590	2·4	1·4	24·5	3,500

We can now find the stresses in the several parts:

Tensile stress at C, the bottom of the slot:

$$\text{Stress at } C = \frac{C.F. \text{ of I.} + \text{III.} + \text{IV.} + \text{V.}}{\text{Area of tooth at } C} = \frac{125{,}000}{203}$$

$$= 616 \text{ kg. per cm}^2.$$

Tensile stress at D, the bottom of the axial duct:

$$\text{Stress at } D = \frac{C.F. \text{ of II.} + \text{III.} + \text{IV.} + \text{V.}}{\text{Area of tooth at } D} = \frac{137{,}000}{285}$$

$$= 481 \text{ kg. per cm}^2.$$

Shear stress on wedge and tooth:

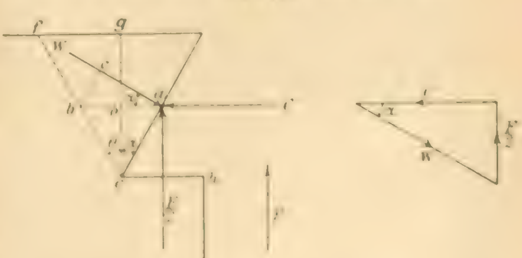
$$\text{Stress} = \frac{C.F. \text{ of III.} + \text{IV.} + \text{V.}}{2 \times 1.5 \times 100} = \frac{57{,}000}{300}$$

$$= [illegible] \text{ kg. per cm}^2.$$

[illegible] The force W in Fig. 27 balances the resultant of the centrifugal force $F/2$ and the compressive force C. It is seen that $W = \frac{F}{2} \cdot \frac{1}{[illegible]}$ where F = III + IV + V. Thus we get

$W = 57{,}000/1.6$ [illegible]

Stress at wedge face = [illegible] kg. per cm².



[illegible]

[illegible]

* The first article of this series dealt with Continuous-current Machines, and the first part of the article appeared in THE ELECTRICIAN of [illegible] 1916, Vol. [illegible]

† [illegible]

We have seen $W = \dfrac{F}{2} \cdot \dfrac{1}{\sin \alpha}$.

Further, moment arm $bc = ab \sin \alpha = (ao - ob) \sin \alpha$
$= (oe \tan \alpha - oe \tan\theta) \sin \alpha$
$= \dfrac{eg}{2} \sin \alpha (\tan \alpha + \tan\theta)$

and section modulus $= \dfrac{L \cdot ef^2}{6} = \dfrac{L \cdot eg^2}{6 \cos^2\theta}$,

whence we have

$$\text{Stress} = \frac{\dfrac{F}{2} \cdot \dfrac{1}{\sin \alpha} \cdot \dfrac{eg}{2} \sin \alpha (\tan \alpha + \tan\theta)}{\dfrac{L \cdot eg^2}{6 \cos^2\theta}}$$

$$= \frac{3 F \cos^2\theta(\tan \alpha + \tan\theta)}{2 \cdot L \cdot eg}.$$

To find the value of θ for which this stress is a maximum, we must differentiate the variable $\cos^2\theta(\tan \alpha+\tan\theta)=\cos^2\theta \tan \alpha + \sin\theta\cos\theta$ and put equal to zero, whence we find $\tan 2\theta = \cot \alpha = eq/ab = 1{\cdot}5/0{\cdot}6 = 2{\cdot}5$, or $\theta = 34$ degrees. Substituting in the above expression, we find.

$$\text{Maximum stress} = \frac{3\times57{,}000\times0{\cdot}82^2(0{\cdot}4+0{\cdot}68)}{2 \times 100 \times 1{\cdot}5}$$
$$= 415 \text{ kg. per cm}^2.$$

Stress Due to Bending Moment in Wedge.—Regarding the wedge as a short beam fixed at the ends and loaded at the centre (worst case) due to the force F=III.+IV.+V., we get

$$\text{Maximum stress due to B.M.} = \frac{\text{bending moment}}{\text{section modulus}} = \frac{Fl}{8} \times \frac{6}{Leq^2}$$
$$= \frac{57{,}000 \; (2{\cdot}8+4{\cdot}0)}{8 \times 2} \times \frac{6}{100 \times 1{\cdot}5^2} = 645 \text{ kg. per cm}^2.$$

(f) Calculation of Stresses in End-bells.—The lay-out of the overhang is shown in Fig. 18. The inner face of the inside coil of the overhang is about 5-6 cm. away from the core to obtain a suitable radius for the copper, which is generally flat strip bent on edge, and to allow ample room for the air to pass into the holes in the pole-centres. The axial clearance between adjacent coils is about 3-6 mm. This development completed, the axial length of the end-bell can be fixed. The overhang copper is usually coned slightly inwards to keep down the external diameter of the bells.

Having settled these dimensions we can now check whether the hoop tension set up in the bell by the centrifugal force of the copper and steel is permissible. In making this calculation, we assume that the copper, insulation and packing near the core is distributed uniformly over an arc equal to the slot-pitch, and near the outer part of the bell over a pitch equal to the axial distance between the centres of adjacent coils. Treating then the end-bell as a thin cylinder under fluid pressure, the stress is equal to the pressure per unit area multiplied by the mean diameter divided by twice the thickness of the bell. (It has been found that the result given by [illegible] with that obtained by [illegible] copper insulation and [illegible] the centrifugal force [illegible] to get the mean [illegible] of the hoop [illegible]

Hoop Tension in Bell near the Core.—The thickness of the [illegible] cm.

Weight of bell [illegible] kg. per cm².

C.F. of bell [illegible] kg. per cm².

H.T. due to bell [illegible] kg. per cm².

[illegible] so that

Weight of copper+insulation [illegible] kg. per cm².

C.F. of copper and insulation $= 100 \times 0{\cdot}025 \times 24 = 60$ kg. per cm².

$$\text{H.T. due to copper and insulation} = \frac{60 \times 48}{2 \times 1{\cdot}9}$$
$$= 758 \text{ kg. per cm}^2.$$

The total hoop tension in the bell near the core is then $727+758=1{,}485$ kg. per cm².

Hoop Tension in Bell at Outer End.—The thickness of bell at outer end is 3·5 cm. and its mean diameter is 59·5 cm.

Weight of bell $= 3{\cdot}5 \times 7{\cdot}8 \times 10^{-3} = 0{\cdot}0273$ kg. per cm².
C.F. of bell $= 100 \times 0{\cdot}0273 \times 29{\cdot}75 = 81{\cdot}1$ kg. per cm².

$$\text{H.T. due to bell} = \frac{81{\cdot}1 \times 59{\cdot}5}{2 \times 3{\cdot}5} = 690 \text{ kg. per cm}^2.$$

The axial pitch between successive coils is 3 cm., so that

$$\text{Weight of copper+insulation} = \frac{0{\cdot}16+0{\cdot}014}{3}$$
$$= 0{\cdot}058 \text{ kg. per cm}^2.$$

C.F. of copper and insulation $= 100 \times 0{\cdot}058 \times 23{\cdot}2 = 134{\cdot}5$ kg. per cm².

$$\text{H.T. due to copper and insulation} = \frac{134{\cdot}5 \times 46{\cdot}4}{2 \times 3{\cdot}5}$$
$$= 890 \text{ kg. per cm}^2.$$

The total hoop tension in the bell near the outer end is thus $690+890=1{,}580$ kg. per cm².

The stress in the neck of the journal should also be calculated by finding the equivalent twisting moment in the usual way, but is not repeated here as the factor of safety is very high.

The stresses in the various parts of the rotor and the corresponding factors of safety are tabulated below:—

Table for Stresses in Rotor.

Part.	Material.	Stress in kg. per cm².	Ultimate stress in kg. per cm².	Factor of Safety.
Tensile stress at C	Carbon S.	616	5,300	8·6
Tensile stress at D	Carbon S.	481	5,300	11·0
Shear on wedge	Phos. Br.	190	3,000	15·8
Shear on tooth	Carbon S.	190	4,200	22·0
Compression on wedge	Phos. Br.	476	3,900	8·2
Compression on tooth	Carbon S.	476	5,300	11·1
B.M. stress in wedge tip	Phos. Br.	415	4,000	9·6
B.M. stress in tooth tip	Carbon S.	415	5,300	12·8
B.M. stress in wedge	Phos. Br.	645	4,000	6·2
Hoop tension in bell near core	Nic.-Steel	1,485	7,500	5·0
Hoop tension in bell near outer end	Nic.-Steel	1,580	7,500	4·7

(To be concluded.)

The Annealing and Heat-Treatment of Non-Ferrous Metals. A Paper recently read by Mr. F. J. Brislee before the Liverpool Engineering Society, described a varied series of researches on the annealing and heat-treatment of non-ferrous metals, special reference being made to the investigation of the more important industrial alloys by the Alloys Research Committee of the Institution of Mechanical Engineers. Among the methods of research are the microscopic examination of metals in section and the use of the equilibrium diagram to indicate the correct temperature of annealing. The physical changes that can be brought about by annealing comprise (1) softening, (2) increase of ductility, and (3) removal of coarse crystallisation caused by rapid cooling from the molten state. The conditions characteristic of the annealing of copper, brass, muntz metal and other materials, are described in detail. One case of special interest is the annealing of Admiralty gun-metal castings, for which a temperature of 900 deg., previous to quenching, gave the best results. Such alloys have to withstand water pressure; if merely cast they are apt to leak, but after annealing they become quite serviceable in this respect.

Switchgear Standardisation.

The following is an account of a discussion which took place before the Birmingham Local Section of the I.E.E. on Dr. Garrard's Paper on the above subject. An abstract of the Paper appeared in THE ELECTRICIAN of Feb. 22 and March 1.

Mr. F. FORREST said it was difficult to see how the standardisation of switchgear arrangements could be introduced with advantage at the present time and especially the standardisation of complete cellular construction in connection with extra-high-tension switchgear. There was, in fact, some likelihood that the extra-high-tension switchgear for large bulk supply generating stations in the future would consist of a simple arrangement of duplicate lead covered cable bus bars and connections, very strongly clamped and supported, with oil immersed isolating switches and with only the oil switch totally enclosed in a separate compartment. If the author's proposals were confined to details of switchgear apparatus only, they would receive almost universal support.

Mr. R. L. GOOLD ventured to suggest that the old-fashioned secretive policy to which the author referred was not an evil presenting serious difficulty. The real obstacle to complete standardisation was the existence of competition—the desire of one manufacturer to excel another. This was an axiom of healthy progress in refinement of construction and evolution of design. Standardisation was eminently desirable in matters such as the back connection studs and nuts, the length of brake, the area of the contact surfaces and in other matters attending the fundamental switch function of conducting and braking an electric current. As to a standardisation of the general style of construction which the author proposed, this was, he thought, a subject which was controversial. In the production of switchgear it was difficult to see how the standard switch would be obtained by co-operative action on the part of designers and manufacturers. The evolution would probably have to involve a process according to which each manufacturer by research and experiment and the utilisation of his knowledge and experience, evolved, probably at some considerable expense to himself, that which he believed to be the most suitable design for a particular purpose. From a number of designs thus evolved it would be necessary to select the standard. Problems would then arise as to how the individual designer was to be compensated for his research and expense.

Mr. A. KROUSE said the author had called attention to what he, the speaker, considered to be a matter of capital importance to the opening up of new national [illegible] without a proper amount of standardisation advantage could not result nationally. Standardisation must not be made to mean the fettering of progress; research and experiment must be excluded from the domain of standardised products, but both these must be carried out systematically with a view to ultimate standardisation.

Mr. G. ROGERS agreed with the author that standardisation of switchgear was urgently required from the point of view of the manufacturer, and also for the convenience of the customer. He knew of scarcely any branch of switchgear, the parts of which were standard, and engineers were constantly up against trouble and needless delay in emergency through the lack of interchangeability of switchgear. The whole matter was one of detail and common sense, and the time was surely come when, as suggested by the author, the Engineering Standards Committee or a Special Sub-committee, should deal thoroughly and systematically with switch and controlling gear. Powers must then be obtained to enforce the adoption by manufacturers of the Committee's findings. [illegible] bars.

Mr. E. C. [illegible] necessitated an extra step on the oil switch fell to [illegible]

Mr. F. [illegible] standardisation [illegible]

was the basis for the production of parts [illegible] and specialists, for instance, china insulators, copper strips, screws, carbons, &c. The external standardisation, on the other hand, greatly affected the operation, replacements and repairs of plant. The great responsibility in fixing rules of this kind was that they must not limit future developments, but rather they must make room for expansion. The rules must, therefore, be mainly concerned with the drawing up of a definite specification to enable buyers to state comprehensively all their requirements, and also to identify and compare the apparatus offered. They furthermore must state clearly and uniformly the tests with which the apparatus would have to comply and the minimum conditions of acceptance. In fixing such rules the experience of operation must be available, and where not available specially equivalent tests must be proposed. Very important amongst these was the endurance test.

Mr. H. W. DIPPLE said he was of the opinion that any standardisation of knife switches should specify grinding and finishing of the contact surfaces, so that the whole of the available area was used. The Post Office usually specified the contact area to be not less than 1 sq. in. per 200 amperes, and the conducting parts to be not less than 1 sq. in. per 500 amperes. He had seen cases on new installations where the switches as received from the manufacturers were in such a state of adjustment that only about one-third of the available area of contact was used; consequently the switches had to be adjusted on the site.

Dr. C. C. GARRARD (in reply) said several speakers, among them Mr. Goold, appeared to think that the effect of standardisation would be to hinder progress, either by eliminating competition between the various manufacturers or by the stereotyping of apparatus. In his opinion the direct opposite was the case, and Mr. Krouse hit the nail on the head in this connection when he said that standardisation and research must go hand in hand. In the absence of standardisation the inventor or designer was compelled to start so low down that he often never reached the level represented by the combined and sifted-out knowledge and achievement upon which he otherwise would have been able to start building. He would again raise the point of the urgent necessity of the standardisation of brass. He would like to make the definite suggestion that a Committee should be set up in Birmingham, working under a delegated authority from the Engineering Standards Committee to deal with this question.

Filaments for Glow Lamps.*

In a recent lecture Dr. Bottger described a new method of producing filaments of tungsten. Hitherto the filaments have been formed from fine tungsten powder. It is stated that this powder is either hammered at high temperatures into small lumps that are then drawn or rolled into filaments, or it is mixed with a binding material and forced at high pressures through fine dies into filaments that are then submitted to a sintering process. Both these treatments produce filaments that consist of an aggregate of more or less regularly packed crystals of tungsten; at the burning temperature of the lamp and crystalline breaks are often formed. The filaments produced by the first process are composed of bundles of crystals drawn out into short lengths and interlaced and welded together. They are at first very ductile and flexible, but after use in the lamp they recrystallise and become brittle. The breakages take place at the junctions between crystals, although the crystals themselves are very flexible.

The new process (German patents [illegible]) is based upon the idea of forming the lamp filament out of one long crystal. [illegible]

* [illegible] Vol. XXXVIII, [illegible]

The New Ironclad Switch Department of the General Electric Co.

In the Report of the Coal Conservation Sub-committee of the Reconstruction Committee it is stated that 95 per cent. of the factories erected for war purposes since August, 1914, use electric power. This fact is an index to the enormous demand which the war has created for electrical plant and accessories. No limit was placed on the output demanded from manufacturers of generators,

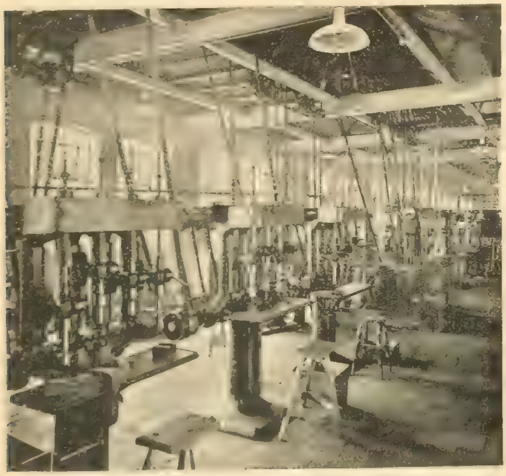


Fig. 1.—Portion of the New Ironclad Switch Machine Shop of the General Electric Co. (Ltd.)

motors, switchgear, transformers and every other class of standard products. In the typical case of the company's switch department, the space available soon became congested by the continuously increasing pressure of orders. At the beginning of 1916 it became apparent that the capacity of the department would need to be a

Fig. 2.—[illegible] Department.

[illegible] conditions. One-half of the top floor of the building was therefore cleared, and fitted up for the manufacture of ironclad switchgear. In spite of inevitable delay in securing the delivery of tools, the new shop proved capable, within a few months, of achieving the 100 per cent. increase in output for which it had been designed. A still further increase has since been attained.

The total space occupied by the ironclad switchgear shop is close on 7,900 sq. ft. More than half the space is absorbed by the machine shop (1,645 sq. ft.), the fitting shop (2,280 sq. ft.), and the machined castings stores (1,095 sq. ft.); and the remainder is divided up between the assembly room (710 sq. ft.), the component stores (839 sq. ft.), the rough castings stores (826 sq. ft.), and the final inspection and paint drying section (480 sq. ft.).

The whole of the machine shop is devoted to the special machining, and the special machining only, of ironclad switches. Various parts which are in general use for electrical work, such as standard bobbin fuse holders, contact clip, and so on, are made in the general works. All the machinery is driven by "Witton" motors, the group system having been adopted as most economical for banks of similar machine tools operating continuously.

In the fitting shop, which is a wide bay arranged with transverse benches, the switches are put together ready for testing and painting. When the switches are completed they are placed on transporter tables, and carried by means of under trucks to the test panel. After being tested at high voltage they pass on to a turn-table in front of the compressed air paint spray, which gives them an even coat of paint with an excellent finish in a much shorter time than is possible with a hand-brush. The switches then move to an open space for drying purposes, and finally to the packing department.

Fig. 3.—Portion of the Assembly Shop for Ironclad Switches.

Thus, from the time they are fitted up and put on the transporting table they are never lifted. This arrangement is not only of the greatest value in securing rapidity of production, but it is practically essential in view of the fact that all the work is done at present by women, who would find great difficulty in lifting the switches.

The transporter arrangement is as simple as it is effective. It consists of a truck and a number of wooden platforms. The truck has two frames, a lower and an upper one, which can be altered in height by means of a lever. Close to each machine or bench is placed a platform, on which the goods are loaded as they are finished. When the load is complete, the truck is brought under the platform, and the upper frame raised so as to lift the platform clear of the ground. The load is then wheeled away, and another platform placed in position for loading up.

The assembling shop and the stores are also laid out with a direct view to facilitating a free and speedy output. Squares are marked out on the floor of the assembly shop, so that the various parts can be conveniently arranged in groups before being taken to the fitting shop. The stores are constructed to reduce delays to a minimum.

Telephone Exchange Transfers and Their Organisation.

The following is an account of a discussion which took place before the Manchester Local Section of the Institution of Electrical Engineers on Mr. F. G. C. Baldwin's Paper on the above subject. An abstract of the Paper appeared in THE ELECTRICIAN of Feb. 1 :

Mr. W. J. MEDLYN (Manchester G.P.O.) referred to the use of insulating separators between the contacts of cut-off relays of the Western Electric type. This method was not practicable in the case of the Peel-Conner type relays, which had been extensively used in recent years. The usual practice in the latter case was to employ a metal clip, which depressed the armature, thereby keeping the contacts open. The clips could be linked together to facilitate rapid withdrawal. In regard to the treatment of subscribers' installations, condensered magneto instruments could be used in connection with a central battery exchange, but such a combination was detrimental to maintenance, economy and efficiency if retained for a long period. The use of change-over switches appeared more costly and less convenient than the condenser method, although in changing over to automatic the use of a change-over switch was unavoidable. The speaker did not agree that it was economical and convenient to condenser existing apparatus in the case of through switches. The equivalent central battery equipment, known as "Bell Set No. 4," was suitable for either magneto or central battery working, and it was preferable to fit these at the outset. The fitting of new central battery private branch exchanges prior to change-over was open to objection. Power would have to be provided specially from primary batteries or by means of a power lead, for all speaking and signalling connections, including talking from extension instruments over exchange lines. After the transfer, power for conversations over the exchange line was automatically supplied from the exchange battery. Under the more variable temporary conditions during the transition period, therefore, complaints would be liable to arise in maintaining satisfactory speech for long-distance working. Further, prior to change-over, no extension could clear through to exchange unless the magneto instruments were left in position, and even then the ring-off signal to the exchange would be rendered unsatisfactory through the effect of the shunt fitted on new central battery P.B.X. switchboards. If the magneto instruments were recovered the P.B.X. operator would have to ring back on every exchange connection to clear and serious traffic difficulties would arise through non-observance of this point. It was doubtful whether the repetition of tests before change-over was justified. Regarding rehearsal, it was the practice of the Post Office to give each man typewritten instructions. During last year (1917) the important transfer of Manchester Central Exchange from magneto and call key to central battery took place, the new exchange being about 400 yds. distant from the old premises. The work involved the transfer of 4,014 subscribers' lines, 1,426 local junctions, 108 junctions from Manchester Trunk Exchange, and 100 private wires. Simultaneously with the transfer a ... no delay ... service between the Central and City Exchanges and 39 trunk centres within a radius of 35 miles was ... [illegible] ... tion by the ... up of 239 tandem junctions. The local exchange cables were mainly made up of 200 to 800 pairs, and the ... in street manholes ... [illegible] ... per cent. of the ... and 2 per cent. provided with tee points.

Mr. G. S. WALLACE (G.P.O., Manchester) ... [illegible]

Mr. C. F. ... (G.P.O., Manchester) ... [illegible]

Mr. J. ... (G.P.O., Manchester) said the ... at the teeing point should be provided with ... to the test ... at the old exchange. No reference was made in the Paper to ... which tested spare or ... [illegible] ... wire junctions, observation and other special circuits. These would have to be tapped out separately. [illegible] ... the joints at the teeing point with ... was not considered as good practice as ... and keeping a record of the circuits working therein, as there was a liability of changes taking place during the transition period.

Mr. J. D. W. STEWART (G.P.O., Manchester) referred to a transfer to C.B. working about 15 years ago when ... were used to separate the springs, and these were removed by the action of the operators plugging into the answering jacks. The speaker endorsed Mr. Wallace's view of the complexity of junction transfers.

Mr. H. H. HARRISON (Automatic Telephone Co.) said that immediately after a transfer very heavy demands were made upon the exchange battery due to (a) subscribers curious to try out the new system and leaving the receiver off the hook, (b) operators not dealing promptly with the calls. This necessitated doubling the carrying capacity of the fuses for a short time. The provision of additional springs on the protectors would no doubt meet with the approval of telephone engineers. The use of separators on the cut-off relays was unsatisfactory as it impaired the adjustment and contact surface.

Mr. E. C. MCKINNON (Chloride Electric Storage Co.) pleaded for more consideration in connection with exchange batteries, which were frequently stored in basements or otherwise for months prior to the transfer.

Mr. S. UPTON (G.P.O., Blackburn) advocated the use of wooden plugs where test jacks were provided on the main frame. A smart transfer was certainly desirable, but a few minutes margin was justifiable in view of the service at stake. In a transfer of any magnitude the centre of control must be a shifting point, beginning with the traffic superintendent at the old exchange, and moving along to the various engineers and other officers concerned. The executive engineer should have the complete plan not only in his mind, but also in graphic form. The speaker, after an experience of a great many transfers, preferred the tee-joint. With one exception, he had never found it necessary to leave a tee-joint open. He would never treat such a joint with beeswax, owing to the breakage of the paper insulation. It should always be possible to close down a tee-joint by covering the whole with a jacket of sheet lead properly soldered and capable of being pressure-tested. A fundamental mistake was frequently made in assuming that a tee arrangement at any manhole must necessarily be a single joint of branches converging at a point. In many cases an apparently awkward tee had been made by the use of one or more lengths of temporary cable trained around the manhole. After transfer the temporary branches could be cut away, leaving stubs on the distribution cable. The fitting of new subscribers' apparatus by the side of the old was essential when preparing for a transfer to automatic working. Two such transfers had recently been made with complete success. Did the findings of the conductivity tests advocated by Mr. Wallace justify the expense? The insulation figure of 100,000 ohms given by the author seemed low, and 200,000 ohms was surely as low as desirable.

Mr. H. M. ... gave a ... of the progressive changes in Manchester telephone equipment during the past 15 years.

Mr. W. F. ... the number of lines in use, the less the relative extra work in teeing them ... [illegible] ... or removing, the joint need not be opened. The teeing through of spares ... [illegible] ... main frame. The joint would not then require to be touched until the time arrived to cut off the old cable.

Mr. F. W. ... [illegible] ... old exchange.

Mr. H. A. ... (Manchester) ... [illegible]

Mr. ... (G.P.O., Manchester) ... [illegible] ... success achieved.

The ... [illegible]

Books Received.

[illegible]

The Electrician.

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Amending the Patent Law.

We hope that the draft Bill to amend the Patent and Designs Act, 1907, will receive the very careful attention of all the engineering societies in this country, for it is a most important measure, and there is still opportunity for further consideration. There should be joint action on a broad basis among the engineering societies, combined, if possible, with those interested in applied chemistry, so as to insure that the final Act will really be in the best interest of the industries of this country.

The proposed Bill affects both inventors and users or manufacturers. Taking, first, the encouragement of the inventor, we think it may be stated without exaggeration that the financial aspect is probably more important than any other. Curiously enough, this aspect does not depend upon the Bill, as the patent fees which are payable can be varied at any time by an Order in Council. As matters stand at present, the inventor must pay a sum of about £100 in fees during the full life-time of a patent. The corresponding payment in the United States is £7, and this is for a patent which is generally considered of greater value in the first instance, and which has a longer life to the extent of three years. That the British inventor should be penalised in this way shows a lack of appreciation of the importance of invention. It is nothing less than a short-sighted policy that the Patent Office should exist as a source of revenue for the Government, such revenue being obtained from inventors, when it is much more important that inventors should be given encouragement in every possible way. Even if the fees were reduced to half the present amount, there would still be no loss in running the Patent Office; and if the fees were reduced still further, we very much doubt whether there would be any financial loss to the country. There certainly would be a material gain in other ways, for an impetus would be given to invention. It is impossible for a country to lead among nations if there is stagnation in invention.

Again, it must be remembered that there are many subjects which are suitable for patenting, but which do not warrant this large expenditure in fees. This remark applies particularly to details and improvements in instruments. In order to receive £100 from a 5 per cent. royalty, a sale to the extent of £2,000 must be effected during the life of the patent. In many cases a sale of this kind may not be realised, and even if it is realised it allows nothing for the expenses and trouble of the inventor, to say nothing of profit on the whole transaction.

In the draft Bill it is contemplated that the full life of patents may be increased from 14 to 15 or possibly 16 years. We are of opinion that the life should not be less than 17 years, and even this errs on the short side. In the popular mind the assumption is made that an inventor in a patent secures the holder of the monopoly in the fortunate enjoyment of a good income. Actually, it usually takes many years to reach a paying stage. Further, there is the question whether all patents throughout the British Empire should not be for the same period, assuming that a patent for the whole Empire is impracticable.

With regard to the user, or manufacturer, it is desirable that a patent should be made as valid as possible. But this is only possible to a limited extent. It is obviously out of the question to guarantee that no prior publication has taken place. The most important point, however, is to ensure that the invention has not already been covered by some other patent. This is a matter which can be decided by the Patent Office much more readily than safe-guarding against prior publication in unofficial documents. It appears to us that it is better not to go unduly far in the search of security, and there is undoubtedly some danger in giving the examiner too much power. In many respects it is better that a patentee should be able to protect perpetual motion, as is possible in this country, than to have his invention refused by an examiner who does not understand the possibilities of some new advance, such as has been the case in the United States.

In introducing "Licences of Right" the new Bill will assist the manufacturer of this country against foreign competition. That inventors will avail themselves of this method of disposing of their patents we are inclined to doubt. It gives the idea that the inventor as a class has not been ready to negotiate with the manufacturer. This, however, is far from the case. Some inventors, no doubt, have very inflated ideas of their own inventions, but, generally speaking, they are only too anxious to come to terms.

As the war drags on it becomes more and more obvious that the patentee in very many cases is paying fees for which he can get no return in the shape of royalties. There are any number of inventions at the present time which cannot be worked, owing to the restricted conditions under which manufacturing is carried on. We hope the Government will not fail to realise their duty towards the patentee in giving an extension of life in such cases. The question arises whether these cases can be considered individually. The longer the war goes on the more impossible will it be to consider such patents individually; the number to be considered will be far too great. It seems therefore that the only possible action to take is to extend all patents alike. This, of course, would mean that those patentees who had already reaped a harvest during the war would still have an advantage. It appears to us, however, that this objection must be set on one side; in any case, the chance is that the patents which have been worked very remuneratively during the war will cease to have the same value when peace returns.

Apart altogether from patent laws, it must be remembered that there are two classes of inventors; there is, on the one hand, the inventor who is on the staff of a firm; on the other hand, there is the independent inventor. The inventor with the manufacturing firm finds his path comparatively safe and easy, because he is working for a firm; and consequently his inventions, if of any value, will be developed by the firm. With the independent inventor, however, the case is very different. The chance is that any manufacturer he approaches will prefer to work out something independent, and thus avoid payment of royalty and the complication of an agreement. The independent inventor, as a rule, has not sufficient capital to demonstrate his invention beyond a very preliminary stage; consequently many inventions lie dormant, and are eventually discarded. We suggest that this attitude on the part of manufacturers accounts for the lack of developments in this country far more than any ill advised patent laws. If the inventor is to flourish and to be an asset to this country, the manufacturer must change his attitude, and must look upon the independent inventor as of potential assistance rather than as a general nuisance.

Problems in Atomic Structure.

As Professor of Natural Philosophy to the Royal Institution, Sir J. J. Thomson, O.M., P.R.S., has of late years delivered an annual course of six lectures on Saturday afternoons. We abstract to-day the first three lectures of this year's series—opened on February 16th—on "Problems in Atomic Structure."

Electrons, Sir Joseph said, in introducing his subject, were one of the things building up the atom; for all substances emitted the same electrons when heated, exposed to ultra-violet light or to Röntgen rays, &c. How many electrons there were in different atoms, we could not settle by direct attack. In positive-ray analysis the mercury atom could lose up to seven electrons, but there might be more. The simplest method was to measure the effects of the wavelets starting from an electron when placed in the path of electric waves. The forces of the latter were constantly changing in direction, and when the direction of propagation was horizontal, the electron would move vertically up and down, generating wavelets which might be counted. What happened when waves met an obstacle? To illustrate this Sir Joseph started a system of long waves (resembling the vibrations of the prongs of a tuning fork) by dipping a bar of wood lengthwise into water; striking another bar [illegible] in the water, broadside on, the waves were regularly reflected [illegible]. But when the obstacle was small (a small disc), a new system of quite different circular waves went out from the obstacle. Similarly a mirror reflected light waves regularly in a definite direction, when the wave-length was small compared to the mirror dimensions; when the two quantities became comparable, there was no definite reflection in one direction, but [illegible] in all directions. The smaller the particles, the more intense the scattering. [illegible] light was more scattered than red light, and Rayleigh had shown that the sky was blue, because the fine particles of the atmosphere scattered the blue chiefly, not because the particles were blue. That the scattering particles might be the air molecules had quite recently been demonstrated by Prof. the Hon. R. J. Strutt, who photographed light scattered by air (freed of all dust) through quartz glass (transparent to ultra-violet) and through a yellow screen; there was scattering only in the first case, and the two photographed spectra confirmed this. Scattered light was polarised and could thus be identified; this was demonstrated with the coarser particles of the dusty air of the lecture theatre, with vapours of amylnitrite and iodine, and with alcoholic mastic solution diluted with water. Röntgen radiations scattered from electrons were also scattered (Barkla). Röntgen rays were electric waves of very small wave length; a horizontal beam of X-rays, [illegible], falling on an electron at B, would make the electron vibrate in the vertical [illegible], and there would be radiation from B in all directions, except in the direction of its own vibration [illegible]; in that direction [illegible] would not record anything, whilst the maximum effect should be seen at right angles to the plane of the paper. [illegible] But [illegible] could be [illegible] into two [illegible] at right angles to each other, there would be some effect in the direction BC and BD, and [illegible] in the direction at right angles to the plane of the paper, which would be vertical to the motion of all the electrons. This had been proved by Barkla.

[illegible]

[illegible] to the wave-lengths λ, was (1) small, (2) large, or (3) intermediate. Any point P at considerable distance from A and B would receive energy along OB [illegible] BP and along OA [illegible] AB; the two paths would not be of the same length, and the phases would differ, by $AC-BD$ (if $BC \perp OA$ and $AD \perp BP$); that difference d would have its maximum when AB was itself in the direction of the incident beam, and if AB were (1) small compared to λ, the scattered energy would be proportional to n^2 (not to n), and the conditions unfavourable therefore for determining n. In case (2) a small change in the angle made by AB and the beam would produce a large change in d, and a difference of several wave-lengths in the phase; the amplitude of the disturbance at P would then be proportional to $\sqrt{n_1}$ and the energy to n; the condition was hence satisfied. In the intermediate case (3), when d and λ were comparable, we had to deal with pairs of electrons arranged in all possible ways. Yet to arrive at an average result, we might consider one pair. The energy of the scattered light reaching P would depend on the angle θ between scattered and incident ray, and it could be shown that, if $\delta = 2AB \sin\frac{\theta}{2}$, then that energy would be proportional to $2+2 \sin\frac{2\pi\delta}{\lambda} \Big/ \frac{2\pi\delta}{\lambda}$. The curve representing this function was that of a damped wave; it had its maximum at its birth, fell off rapidly then to a minimum, to attain a smaller second, and again a third still smaller minimum. This effect of scattering could be demonstrated. When a plate of glass was powdered with lycopodium and held in the lantern beam, the spot of light was seen surrounded by coloured rings, quite close to the spot, which corresponded to the maxima and minima of the curve; this was not the ice crystal effect of halos due to refraction by the crystals, which could be imitated by a glass plate on which alum crystals were deposited. When we had n electrons the expression [illegible] scattering was greatest and proportional to n^2 for $\theta = 0$, when P would be in the direction of BA.

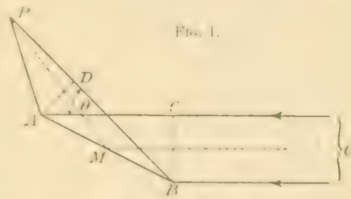

Fig. 1.

The scattering was not symmetrical fore and aft, except in case (2), but larger in the forward direction of the beam, owing to interference. [illegible] n_1 of course. Pulses from particles would also be in phase in the case [illegible] number of electrons were in the same plane; no matter what λ, the light scattered to P would have a maximum for that incidence which [illegible] structure studies by X-rays.

[illegible] tions, and some of their conclusions were probably exaggerated; [illegible]

static equilibrium differed greatly in the two cases. Attraction and repulsion had to balance one another; in case (2) equilibrium would be stable, any slightly displaced electron would return to its position; in case (1) equilibrium positions could be found, but the equilibrium proved unstable. In the demonstration Sir Joseph made use of three floating vertical magnets; the first represented the + charge, the second smaller (poles reversed) a negative charge, the two being rigidly connected; the third small magnet (also negative) was in equilibrium with the first two only in one position, axial to the other two; if slightly displaced from that position, it was either drawn to the others or driven right away. Assuming the inverse square law of attraction and repulsion, there was thus in case (1) no static equilibrium; it would be the impossible case of Mahomet's coffin which was balanced by a magnet, itself balanced by the coffin. But if the electrons were in motion, equilibrium as in the planetry system was possible. In his calculations Sir Joseph assumed the forces of attraction and repulsion to be represented by $(Ee/r^2)-(c\ r^3)$, where E and e were the positive and negative charges at distance r. What were the quantitative relations between the one + charge and the negative charges? The following figures showed that, for case (1), a nucleus surrounded by a ring of n electrons in the same plane, very large values of E were required to neutralise the e.

n	1.	2.	3.	4.	5.	6.	8.	10.	12.	14.	16.	18.	20.
E	[illegible]	0·75,	1·58,	3·1,	4·76,	7·32,	14·2,	24·16,	38·95,	58·44,	83·6,	115·4,	154·5

Thus there would be an excess of negative charge when n was smaller than 5, and the two charges would be equal between 5 and 6. If the electrons were not all in the same plane, as was more likely, the calculations were difficult; but he had found that the four electrons at the corners of a tetrahedron, and the eight at the corners of an octahedron would be stable; the eight at the corners of a cube would not be, unless the cube were so twisted that the lower four corners fell (in projection) halfway between the four upper; the 20 electrons at the corners of a dodecahedron would be unstable. One might also argue that the + charge of 150 could hold $20e$ (see figures above); there would remain a charge of $150-20=130$, which could further hold $17e$ in a second ring; and so on. There would in case (1) be more electrons in the inner than in the outer ring, whilst in case (2) the electrons would be more numerous in the outer rings.

Into such considerations entered the question of atomic volume, which, as usually defined: atomic weight/density, had a definite meaning only for atoms like incompressible spheres. To illustrate this difficulty, Sir Joseph referred to the "dilatency" studies, which Osborne Reynolds had elaborated almost into a theory of the universe. When one walked on the wet, fine sand of the sea-shore, the pressure of the foot seemed to dry the sand underneath, not to make it look more wet, because pressure on the well-settled grains increased the [illegible] them.

Leaving this point for the present, Sir Joseph (third lecture) went [illegible] which he now wrote $(E\ [illegible])-(h\ r^3)$ [illegible] so far not [illegible]. The law of inverse squares was insufficient to [illegible] the phenomena, and he had assumed a repulsion decreasing with the cube of the distance, which would predominate [illegible] small distances. On this assumption there [illegible] and one electron; further two electrons at ends of a diameter, a little nearer to the centre; three electrons in a triangle, and four at the corners of a tetrahedron; [illegible] the centre a little [illegible] equilibrium. But if a ninth electron were added, equilibrium was no longer possible, [illegible] the 10th would take up the position of the second, the 11th of the third, on [illegible] the 17th and 18th [illegible] same vertical column, e.g., Li, Na, K, had similar properties, which [illegible] provided the repulsion were independent of the positive charge. We [illegible] to another. The periodic changes in

the atomic volumes had first been pointed out by Lothar Meyer; plotting these volumes against the atomic weights, however, he had found that the atomic volumes first diminished to a minimum for C, and then increased again through N, O, F, to a peak for Na, to drop again and to attain a second peak for K, &c. In the lecturer's view the atomic volumes should diminish all through an octave, and then jump suddenly to a new peak, and the recent curves of G. Le Bas, deduced from the study of the molecular volumes of substituted hydrocarbons, indeed suggested that the atomic volumes of N, O, F(?), were still diminishing, and that similar relations held for Si, P, S, Cl, &c. That was of critical importance, but required much further study.

That the atom really contained positive and negative charges seemed to be supported by the piezoelectric experiments of P. Curie (1883). Certain crystals, distinguished by asymmetric faces like quartz and tourmalin, assumed electric polarity when they were compressed. The crystals had to be cut at right angles to a main axis for this purpose; the slab of mineral was placed between two metallic plates, the upper joined to an electrometer, the lower earthed, and a pressure was then applied (by hand through an insulating rod) on the upper plate; the electrometer was deflected, and the deflection reversed when the slab was turned upside down. It was not a friction or other effect apparently, but merely changing the mutual positions of the charges in the molecules. Transparent (insulating) tourmalin was, for this purpose, better than black (conducting) tourmalin and better than quartz, which was often twinned. But quartz (not tourmalin) showed another peculiarity; when the slab was pulled, being suspended vertically, it also became electrified, and this property had been utilised by Curie to adjust potential differences, and by Sir Joseph himself to measure by hydrostatic pressures.

Going back to the electron rings, the lecturer pointed out that on the arguments advanced, the properties of the different alkali metals, of the different halogens, &c., should be almost identical instead of being similar, if the repulsion were quite independent of the number of electrons. But there were reasons to assume that it was not, and to explain this he suggested that the atom consisted of a positive charge and electrons, and further of some special particles q. One of the reasons for suggesting a further constituent was the difficulty to explain, e.g., the two spectra (one very complex) of hydrogen, the atom of which was supposed to consist merely of one nucleus and one electron. If there were such particles in addition, of which the atom could be deprived in some way, then there would be different atoms of hydrogen, containing more or fewer q, and the repulsive force and the orbit of the electron would change with the q. In a certain way that suggestion resembled Bohr's theory of the atom, according to which the orbits of the hydrogen electron might be large or small, the moment of momentum changing by definite units in jumps, and radiation occurred during these jumps. Sir Joseph found a difficulty in understanding the origin of this radiation; it seemed clearer to assume that the radiation was caused by the expulsion of a q particle, and the consequent change in the equilibrium of the electron. But we had to find evidence for the existence of different kinds of hydrogen atoms. Spectroscopy could not supply that evidence; but it was striking that there were stages in the electric pressure causing ionisation, at 11 volts, 15 volts, &c., and we might thus measure the energy required to tear out one of the q particles.

(To be continued.)

A Survey of Methods of Directing and Concentrating Light.*

By Lieut.-Commander HAYDN T. HARRISON, R.N.V.R.

The simplest form of light sources up to quite lately has been the arc lamp consuming pure carbon. The well known polar curve of such a lamp can be reduced to visible area of crater, and is governed by Lambert's law, bearing in mind the shadow or interruption of light caused by the negative carbon, and the intrinsic brilliancy of the boiling carbon crater, taken as 85,000 c.p. per square inch.

This law is so definite that if photometric measurements when plotted give a different curve from the usual, it is proof that the source of light is not a plane surface but convex. In the high candle-power searchlight lamp which has been developed during the last few years, this phenomenon occurs despite the fact that there is a deep crater, thus proving that the light source is not the boiling carbon, but the gaseous contents of the crater, which actually boil over, and so change the plane surface into a convex shaped source of light.

When using reflectors the area of light source is reproduced in a varied form by means of reflection, which projects it over various

* Abstract of a Paper read before Illuminating Engineering Society.

areas, the intrinsic brilliancy of which must be inversely proportionate to the area of the original light source.

Some idea of the luminous value obtained by the concentration of light can be gathered from the following table, which has been calculated by dividing the solid angle of the beam produced into the solid angle of luminous flux, which is utilised. Three examples of the latter are given, namely, 270 deg., 180 deg., and 90 deg., being the equivalent of deep, medium, and shallow reflectors. The last type is that generally used in conjunction with the arc for searchlight purposes.

Total Angle of Dispersion. Degrees.	Multiplying Power of Beam. 270 deg.	180 deg.	90 deg.
1	42,675	25,000	7,325
2	11,380	6,600	1,950
3	4,918	2,940	862
4	3,798	1,640	482
5	1,792	1,050	308
10	448	262	77
20		65	19
45		13	3·86
60		7·2	2·1
90		3·4	1·0

It is quite usual with shallow parabolic reflectors for the luminous power of the beam to reach 800 times the mean power received from the lamp, showing that the usual dispersion is between three and four degrees. With the more modern lamps the luminous power is increased 1,000 to 2,000 times that of the lamp, owing to its being possible to focus the small light source to less than three degrees.

With metal reflectors of the 270-deg. class, a multiplication of 2,000 can be obtained when using small incandescent lamp filaments, but such a small dispersion as 5 deg. is rarely required for other than signalling work.

Dispersion takes place due to the area of the light source, and as dispersion in any degree must naturally increase the diameter in proportion to the distance, it follows that it increases the area illuminated in proportion to the square of the distance.

From this the two well-known laws are derived: (1) That beams closely approaching parallel can still be considered as following the square law, provided the illumination derived from them is measured at sufficient distance to eliminate any error due to the area of the secondary source or mirror; (2) that the luminous flux from a parabolic mirror focused to small dispersion is proportionate to the square of its area divided by the square of the area of the source.

It has been my duty during the last few years to develop into practical form a lamp, of which the intrinsic brilliancy per unit area of light bears the relation of 250,000 to 300,000 c.p. per square inch compared with 80,000 to 90,000 c.p. with the ordinary arc. Thus it would be unwise to consider the limit of intrinsic brilliancy as having been reached.

The increase of intrinsic brilliancy of light sources more particularly affects the projection of light into narrow areas, such as used for naval and military purposes, and for flood lighting, headlights, or theatrical work.

One serious disadvantage of the specular type of reflector when used in conjunction with filament lamps, namely, that they project a very clear image of the light source itself (in other words, the filament), from which it naturally follows that the degree of illumination produced by the beam varies considerably over various parts of the illuminated area. This fault is corrected to a certain extent by using a deep prismatic reflector.

[illegible]

[illegible]

[illegible] thicknesses of glass through which the beam has to pass.

[illegible]

and diffusing devices which have proved very unsuitable when used in conjunction with vacuum lamps.

The use of diffusive reflectors postulates that the light source is visible in certain positions. In order to overcome this, it is usual to make the reflector as deep as possible.

The use of ceilings as secondary light sources as in the case of indirect lighting, will probably be largely developed after the war.

A disadvantage of indirect lighting as carried out in many instances is excessive diffusion of the light. This can be overcome by concentrating the light source on to a smaller area of the ceiling, which small area can be specially prepared, or covered with a suitable device, to increase its reflecting efficiency and permit of its being cleaned when necessary in order to maintain such efficiency.

At first sight it would appear unwise to concentrate light in order to diffuse it again; but the conditions are not unlike those of the supply of electrical energy, when it is often found more convenient to generate at a low pressure, transform to a high pressure to facilitate transmission to a distance, and then transform again to a convenient pressure for domestic and other purposes.

The increase in efficiency of artificial light sources also tends towards the increase in power. Thus, it is not unlikely that some of what have hitherto been the favourite methods of interior illumination (such as the use of large numbers of small units placed adjacent to the objects they are required to illuminate) will have to disappear, and modern schemes on quite different lines will take their place.

Correspondence.

ELECTRIC SUPPLY IN GREAT BRITAIN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with considerable interest your comments on my communication of last week, but I venture to think you construe my criticisms as supporting the principle of generation on a small scale as compared with a large scale; this, of course, would be absurd.

Two of your remarks are quite to the point, viz.: "If they could start Electricity Supply in this country afresh," and "if the supply over the whole area had been in the hands of one authority." What a different world this would be "if"! We have, therefore, to make the best of things as we find them, and my contention is that we are not going to make the best of things by taking such an immediate plunge into the dark as the Interim Report suggests without more substantial evidence to support it.

When a Committee is appointed to deal with the conservation of coal and goes out of its way to make such a deliberate attack on Municipal ownership, one is bound to probe deeper still and ask with greater emphasis Why?

I quite agree with you that the Report deals with general principles—in fact on the main question it is general to the extent of vagueness, but when it refers to municipal control it goes into detail even to the extent of a lengthy appendix.

I challenge your conclusions on several points, but in view of my previous lengthy communication I will not trespass further at the present time except to add the following comparison.

[illegible]

[illegible]

[illegible]

large any more than one section of the community is external to the whole. If the inhabitants of the parish, or if the community generally, gain by the small station being made subservient to a large scheme, we must expect such a policy to be followed. This does not mean, however, that the engineer and staff of the small station need suffer. Provided they do not suffer we feel that they should have no cause for complaint.—ED. *E.*]

Combined Electric Power and Water Heating Stations.

We have received from Mr. W. M. Selvey a pamphlet setting forth the advantages of supplying heat from electricity stations in the form of hot water in combination with electric power. It is pointed out that heat for commercial purposes may be classed as (1) high-grade heat and (2) low-grade heat. High-grade heat is necessary for [illegible] plant; but, unfortunately, the greater part of the heat is rejected as low-grade heat. The suggestion is that this low-grade heat should be utilised in the form of hot water distributed for [illegible]. If a 12 in. diameter pipe is properly laid and contains water at a maximum temperature of 160°F., moving with a velocity of, say, 3 ft. a second, the water could be transmitted 4 miles with a [illegible] 13 per cent. of the heat. If a network of pipes were laid down like a low-tension electrical distribution system, hot water could be distributed at temperatures varying from 140°F. down to 120°F. The low-grade heat would be obtained by tapping steam from the turbine at such a vacuum as corresponds to the hot-water temperature required. The hot water could be taken from the main condenser, extracted by a battery of centrifugal pumps, and after purification this would be delivered at a considerable pressure into distribution mains, which would be erected in subways containing electric cables and other mains. A great part of the water would be used for domestic purposes, for heating, &c. The water not actually used would be kept in circulation. A diagram is given showing two systems of pipes, the go and return. The heating plant would be connected between these two and the water would flow through these, returning eventually to the power station.

The following approximate figures are given as showing the feasibility of distribution heat as hot water on a large scale:—

[illegible] Bulk Supply

[illegible]	12 in. diameter by 4 miles long.
[illegible]	100°F. above atmospheric temp.
[illegible]	[illegible] B.T.U.'s per sq. foot per hour per 1°F. temperature difference.
[illegible]	1,740,000 B.Th.U.'s
[illegible]	53,000,000 B.Th.U.'s per hour (153,000 gallons per hour).
[illegible]	3.3 [illegible] (maximum 1.65 [illegible]).
[illegible]	13.2 [illegible] (maximum 6.6 [illegible]).
[illegible]	[illegible] lb. per square inch.
[illegible]	100 lb. per square inch.
[illegible]	80 kw.
[illegible]	15,000 kw.
[illegible]	[illegible]
[illegible]	[illegible]

[illegible]

[illegible]	£80,000	
[illegible]	£150,000	
[illegible]	[illegible]	
[illegible]	0.104	0.3[illegible]
[illegible]	0.2[illegible]	
[illegible]	0.04[illegible]	0.104
[illegible]	[illegible]	

[illegible]

[illegible]

Parliamentary Intelligence.

LOAN TO SHROPSHIRE ELECTRIC POWER CO.

In the House of Commons on Thursday last Sir W. Evans stated, in reply to a question, that up to the present £180,000 had been advanced to the Shropshire, Worcestershire and Staffordshire Electric Power Co., and that it was anticipated there would be a further loan of £80,000 to complete the extensions to meet urgent war demands. So far as he knew there was no truth in the suggestion that the promoters of this Company were originally a German syndicate. All the directors were British born, with the exception of one, born in Saxony, who became a naturalised British subject in 1881. The power was urgently required for war purposes.

Londonderry Corporation Bill.—This Bill was read a second time in the House of Commons last week, but an instruction was given to the Committee on the Bill to insert a clause to provide that the Corporation shall not borrow for the provision of trolley vehicles and the electrical equipment and the construction of the other works necessary for those vehicles any greater sum than £50,000 until they shall have taken steps to introduce into Parliament in the next Session available for Private Bill legislation, or the next succeeding Session, a Bill for the extension of the City boundaries.

Legal Intelligence.

Thomson v. Tarrant.

On Monday Mr. Justice Roche heard an action brought by Thomson & Son (Motor Factors, Ltd.) against Tarrant & Co., for the recovery of £427. 10s. 5d. in respect of 11,324 pocket electric lamp batteries returned as faulty. Defendants contended that plaintiffs were not entitled to return from 33 to 40 per cent., as the seals of that number had been broken contrary to the instructions.

Mr. CAMPION (for plaintiffs) read the contract stating that they were to be allowed to return faulty batteries.

Evidence was called for plaintiffs to the effect that they had not broken any of the seals. The batteries came from America, and were not in damp-proof cases. Some of the seals had been broken by damp, and others by the voyage. Altogether 11,324 of the batteries sent to plaintiffs were defective. Plaintiffs paid 9s. 3d. a dozen for the batteries, and they were sold retail at 1s. 3d. each.

Evidence was called in defence to show that it was not the custom in the trade to take back batteries the seals of which had been broken.

His LORDSHIP elicited that out of 900,000 consigned to defendants from America 200,000 were faulty, and expressed a hope that that rubbish was sent before there was such a shortage in shipping.

In giving judgment his LORDSHIP said that he was satisfied plaintiffs did not break any of the seals; but, apart from that, there was no contract between the parties that plaintiffs were not to be allowed to return batteries the seals of which had been broken. The dealers' notice on the carton was no part of the contract in this case. He entered judgment for plaintiffs for the sum claimed.

Volunteer Notices.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Oxford-street, W. 1.

Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.

Orders for the Week.

Officer for the Week.—Sec. Lieut. E. A. Ullmann.

Next for Duty.—Lieut. C. E. Campbell.

Monday, March 11.—No. 3 Company, 6.30-8.30. Recruits' Drill, 6.30-8.30. Signalling Section, 6.30-8.30.

Tuesday, March 12.—Lecture on Demolitions, 6.30. Physical Drill and Bayonet Fighting, 7.30.

Wednesday, March 13.—No. 1 Company, Knotting, &c., 6.30-8.30. Recruits' Drill, 6.30.

Thursday, March 14.—No. 2 Company, Knotting, &c., 6.0-8.0. Recruits' Drill, 6.30-8.30. Signalling Section, 6.30-8.30. Ambulance Section, 6.30-8.30.

Friday, March 15.—Musketry, 5.30-8.0.

Saturday, March 16.—Entrenchments, &c., for the whole Corps, 2.45-[illegible]. Recruits' Drill, 2.45-4.45.

[illegible] Notice.—All drill will take place at headquarters unless [illegible].

[illegible] attend for [illegible] Instruction with the Companies.

[illegible] officer will attend for the examination of recruits on Thursday evening at 6.0.

Commercial Topics.

Application to Increase Maximum Prices of Current.

Electric supply companies who propose to apply to the Board of Trade for revision of the maximum prices scheduled in their provisional orders will be interested in the communication from the Board of Trade received by Mr. T. W. Cole, secretary of the Provincial Electric Supply Committee, in regard to the conference with the Board of Trade on Jan. 16.

The letter, which sets out the various particulars required to be furnished by such companies and the procedure to be adopted, states that the Board have given careful consideration to the suggestion made at the conference that a general order should be made in the matter of the revision of maximum prices, but they are satisfied that the adoption of such a course is not practicable, and that each case must be considered on its merits. The Board will deal as expeditiously as possible with any application which they may receive for a revision of maximum price. Each company when submitting an application should furnish particulars on the following points:—

(1) The amount of dividend paid on the ordinary shares for each of the last five years of account; (2) a comparative statement of receipts and expenditure for the last five years respectively; (3) the proportion of energy supplied respectively (*a*) to contracts with controlled establishments, (*b*) under long-term contracts, and (*c*) to ordinary consumers (i.) for lighting and (ii.) for power, with a statement of the prices now charged in respect of each class of supply; (4) the increase in revenue charges per unit generated attributable to increased cost of wages, fuel, oil and plant since the outbreak of war (exclusive of the increase of wages due to the recent award relating to the 12½ per cent. bonus); (5) what the recent 12½ per cent. bonus award will represent per unit generated.

Each company should at the time of making the application serve a notice thereof on the local authority for every district in their area of supply, which notice should state that the Board will be prepared to consider any representations which may be made to them in the matter if received within 14 days of the date of the notice. Where charges are made to consumers on the maximum demand system, the Board are of opinion that any general percentage increase which may be added to the consumer's account to cover war contingencies should not be taken as infringing the provisions relating to maximum price contained in the Companies Acts and Orders provided that the average charge per unit to any consumer does not exceed the maximum prescribed.

* * * *

Private Bill Legislation.

In December last a sub-committee of the original Reconstruction Committee was appointed to inquire into the general question of simplifying the procedure of obtaining Parliamentary powers for public purposes with reference to possible extensions of the existing provisional order system.

In their report, which was issued last, week the sub-committee give an outline of the development of the present system and suggest that on the conclusion of the war there will be large arrears of legislation to be undertaken. It is therefore desirable that the process of obtaining the requisite powers should be simplified and the expense reduced as far as possible. The following is a summary of the Committee's recommendations:—

The introduction of legislation in order to bring up to date the several Acts conferring general powers on local authorities and powers for carrying out public utility undertakings and their periodical revision; the consolidation of local Acts; the extension of the Provisional Order system so as to enable powers to be given by provisional order similar to those which have been given by special Act under similar circumstances; the granting of powers for the compulsory acquisition of water rights by way of provisional order; the extension of powers to make orders not requiring confirmation by Parliament; the grant of powers enabling departments of State to make rules for regulating procedure in connection with provisional orders; and the appointment of a joint committee of the two Houses of Parliament to consider questions affecting the procedure to be prescribed in relation to private bill legislation generally.

We hope that effect will be promptly given to the recommendations of the Committee, for there can be no doubt of the necessity for cheapening and simplifying private bill procedure. Hitherto the promotion of private bills has been a very expensive luxury and the results are frequently uncertain, as witness the fate of the Electric Power Bill of 1914. [illegible] 1918 [illegible]

* * * *

Bank Amalgamation.

The Government has appointed a Committee to consider and report to what extent, if at all, amalgamations between banks may affect prejudicially the interests of the industrial and commercial community, and whether it is desirable that legislation should be introduced to prohibit or [illegible] under which they might continue to be permitted.

[illegible] of the Committee [illegible] Hon. Rupert Beckett, Hon. Herbert Gibbs, Sir Arthur Haworth, Bart., Sir John Purcell, K.C.B. [illegible] Douglas Vickers.

Zinc Marketing.

It is reported that arrangements are being made by British zinc smelters whereby the buying and distribution of their supplies of raw material are entrusted to one of their number.

The British Zinc Smelters' Conference, which was formed some time ago to protect existing interests, will now be put into more concrete form. The Conference will remain operative so long as the market for spelter is controlled; subsequently, however, it will probably be continued, and may handle the sales of spelter produced by its members.

* * * *

A Proposed Metal Bank.

It is announced that arrangements are being made for the formation of a new bank, the principal object of which will be to finance and support the development of essential metal industries of the country.

Substantial progress has been made in remedying the deficiencies in the smelting capacity of this country, but it is felt that a special bank is required to stimulate that development, and to place the metal industry in an assured position to meet German competition after the war. The capital will be one million sterling.

British Manufacturers and Australian Works.

Owing to the projected [illegible] £250 and upwards [illegible] Commonwealth [illegible] and to other reasons, there is a tendency to erect works in Australia. Recently Messrs. Lysaghts (Ltd.) decided to make arrangements for the establishment of a plant for the manufacture of galvanised iron adjacent to the Broken Hill Proprietary Co.'s Newcastle iron and steel works. Already some foreign manufacturers have erected works in Australia in order to be able to save the heavy cost of freight on the raw materials required for their business, which they derive from Australia.

Electricity Supply.

Extensions.

Dundee.—The Electric Committee has decided to proceed with a modified scheme of electricity extensions at a cost of £60,000 to £70,000.

In reply to a question by Mr. Fletcher as to getting power from the Tay, the engineer (Major H. Richardson) pointed out that they were greatly handicapped by legislation and river rights. The only way to get power from the Tay was by building a big barrage across the river above Dundee with a wire and a power-house. But the cost of building the barrage would be a big thing, and the cost would be over six figures. There was much more power in the Tay than they could use at present, but the cost was a very big thing.

London County Council.—At the meeting on Tuesday sanction was given to Islington Council to borrow £3,571 for its electricity undertaking (£972 for mains and £2,599 for transformers), and to Poplar Council to borrow £8,000 for two 1,000 kw. converters.

Manchester.—On Wednesday the City Council decided to apply to the L.G. Board for permission to borrow £125,000 for providing plant at distributing stations and for extensions of mains.

General.

Carnarvon.—The Council have refused the application of the National Electric Construction Co. to increase their charges for electrical energy.

Electricity in Dublin Docks.—At a meeting of the Dublin Port and Docks Board last week it was decided to take electricity in bulk from the Corporation at a price to be agreed upon by the parties.

Electricity Economy.—The Controller of Coal Mines (Mr. Guy Calthrop) again appeals to consumers of electricity throughout the country to economise in the use of electricity and to see that every electric switch over which they have control is used as sparingly as circumstances will allow.

[illegible]

Islington, London.—[illegible]

[illegible] for controlling public lighting [illegible]

[illegible]

Lancaster.—The Council has granted an honorarium of £100 to the assistant electrical engineer for extra work done during the past year in the absence of the chief engineer.

Leicester.—The Council has referred to a special committee proposals to increase the salary of the electrical engineer (Mr. T. R. Smith) from £900 to £1,000.

Salford.—The Electricity Committee has accepted the offer of Manchester Corporation for a supply of electricity in bulk.

Manchester will supply up to 2,000 kw. during the first year, 3,000 kw. during the second and 4,000 kw. during the third year. The charges are to be for the first 2,000 kw. £2. 15s. per kilowatt per annum, for the third 1,000 kw. £2. 10s., and for the fourth 1,000 kw. £1. 10s., plus 0·2d. per unit metered. The minimum annual payment for the first year will be £5,500, for the second year £8,000, and the third year £9,500. For every 1s. increase in the cost per ton of coal over and above the first 10s. 0·013d. per unit is to be added to the charges. If the agreement is not renewed at the end of three years, any expense in recovering mains shall be borne by each Corporation in respect of the mains in their respective areas.

Salford Electricity Committee has accepted an offer of the Lancashire Electric Power Co. to continue to supply electricity in bulk for another year from April 1, 1918.

Electric Traction.

Blackpool.—The Cleansing Committee has decided to purchase another electric motor vehicle at a cost between £800 and £900.

Edinburgh.—The Tramways Committee has decided to apply for additional powers in their provisional order to extend the proposed Queensferry tramway to the west end of the town of Queensferry.

Ipswich Experience of Electric Vehicles.—In a recent report by the Borough Surveyor of Weymouth information is collected from different towns as to their experience with different electric vehicles.

By a mistake Ipswich is referred to as having in use a Ransomes "Orwell" type 3-ton vehicle. The vehicle in use at Ipswich is one supplied by the General Vehicle Co. In connection with the information given under Ipswich the borough surveyor also stated that he believed that, where a journey less than 2½ to 3 miles had to be made, the advantage lies with horse haulage, but he intended that the 2½ to 3 miles should be the complete journey (there and back), or that horse haulage had the advantage only within a radius of 1¼ to 1½ miles. It might be added Ipswich Corporation is absolutely satisfied with the results that have been obtained from the vehicle in question.

Rochdale.—The Corporation has decided to purchase three electrically-driven motor lorries for the cleansing department.

Tramway Workers' Wages.—On Tuesday Mr. Barnes and Mr. Roberts had conferences with Mr. R. Williams, secretary of the National Transport Workers' Federation, on the demand for recognition by tramways and other passenger vehicle undertakings, and for an extension of the Askwith award of £1 per week to commercial vehicle workers to workers upon passenger vehicles.

Another conference between the parties took place yesterday (Thursday), and it is probable that an amicable solution of the difficulty will be effected.

Telegraphy and Telephony

Radio-Telegraph Progress.—The number of radio-telegraph stations of the opening of which the Berne Bureau was notified at Dec. 31 was 657 coastal stations (for communicating with ships), [illegible] ship stations and 88 fixed stations (for communicating with [illegible] fixed stations).

The "Telegraph and Telephone Journal" announces that powerful [illegible] will be erected in the near future on the Pacific coast of the [illegible] [illegible] Brazil, Guadeloupe, the [illegible] [illegible] Parliamentary grand [illegible] with a view of studying a [illegible] telegraph, [illegible] [illegible] the Metropolis and the [illegible]

Telegraph Rates to Russia.—[illegible] Telegraph Co. [illegible] ordinary [illegible] [illegible] old and [illegible]

Miscellaneous.

The B.E.A.M.A.—[illegible]

British Industries Fair.—This Fair will be held in the Pennington-street premises of the London Dock from March 11 to 22 inclusive.

Admission to the Fair will, as in former years, be confined to bona fide trade buyers, and only manufacturing firms in the following industries are permitted to exhibit: Earthenware and china, glass, fancy goods, paper, stationery, printing (including book publishing) and toys and games.

Enemy Firm Wound Up.—The Board of Trade has ordered the United Carborundum & Electrite Works (Ltd.) to be wound up, and Mr. C. Eves, 62, New Broad-street, London, E.C., has been appointed Controller.

Trading With the Enemy.—The "London Gazette" of March 1 contains additions to the list of persons and firms with whom trading by persons and firms in the United Kingdom is prohibited.

These include the following: *Cuba.*—Campania Anonima Electro Alemana Cuba (Havana). *Guatemala.*—Empresa Electric Light & Power Co. (Guatemala City). *Peru.*—La Electrica Moderna (Lima). *Spain.*—La Electrica de Prat de Llucanes (Barcelona).

Imports.—The following are official values of electrical machinery material and apparatus imported into this country during Jan., 1918, with increase or decrease compared with Jan., 1917:—

Electrical machinery, £450 (decrease £346); including generators and motors other than for aeroplanes, motor cars and cycles, £57 (decrease £153; and electrical machinery unenumerated, £393 (decrease £193); telegraph and telephone apparatus, £3,920 (increase £822); electric wires and cables, rubber insulated, £315 (decrease £10,267); carbons, £5,697 (decrease £1,391; glow lamps, £33,797 (increase £14,101); parts of arc lamps and searchlights (other than carbons), £12,149 (increase £184); primary and secondary batteries, £46,439 (increase £1,962); meters and measuring instruments, £1,139 (decrease £4,125; electrical goods and apparatus unenumerated, £27,491 (decrease £17,618). Total of electrical goods and apparatus other than machinery and uninsulated wire, £130,947 (decrease £45,105).

Exports.—The exports of electrical machinery, material, &c., during Jan., 1918, with increase or decrease compared with Jan., 1917, were as follows:—

Electrical machinery, £89,901 (decrease £87,123), including railway and tramway motors, £2,490 (decrease £95); other generators and motors except for aeroplanes, motor cars and cycles, £45,334 (decrease £58,801); and electrical machinery unenumerated, £404 (decrease £386); telegraph and telephone cables, submarine, £17,069 (decrease £11,756); other than submarine, £18,592 (decrease £105,504); telegraph and telephone apparatus, £20,729 (increase £3,372); other electrical wires and cables, rubber insulated, £6,610 (decrease £43,456); with other insulation, £6,478 (decrease £29,694); carbons, £445 (increase £93); glow lamps, £8,325 (decrease £2,679); arc lamps and searchlights, £1,789 (increase £1,703); parts of arc lamps and searchlights (other than carbons), £757 (increase £470); primary and secondary batteries, £6,389 (decrease £13,540); meters and measuring implements, £9,359 (decrease £4,729); transformers, £4,728 (increase £1,520); switchboards, £2,996 (increase £1,175); electrical goods and apparatus unenumerated, £31,418 (decrease £32,375). Total of electrical goods and apparatus, other than machinery and uninsulated wire, £135,684 (decrease £235,400).

Tenders Invited.

Electric Bell Fittings.

The Commissioners of H.M. Works, &c., invite tenders for the supply of electric bell fittings for six months from the 1st prox. Forms of tender, &c., from the Controller of Supplies, King Charles-street, Westminster, S.W.1; and tenders addressed to the Secretary, H.M. Office of Works, &c., Storey's-gate, London, S.W.1, must be delivered before 11 a.m. on Wednesday, March 13.

Water Pipes and Values.

Manchester Electricity Committee require tenders by 10 a.m. March 13 for (1) low pressure values for circulating water pipes for cooling towers and for (2) low pressure water pipes and supports for cooling towers. Specifications from Mr. F. E. Hughes, Town Hall, Manchester.

Mechanical Stoker.

Tenders are required by noon March 11 for the supply of a [illegible] type mechanical stoker for Fleetwood Council's electricity [illegible]. Particulars from the Electrical Engineer.

Electrical Stores and Fittings.

Belfast Tramways and Electricity Committee invite tenders for the supply of materials, including lubricating oils and petrol, ironmongery, v.b. insulated cable, v.i.r. cables and wires, electrical [illegible], [illegible], carbon and carbon brushes, meters, [illegible] [illegible] switches and cut outs. Forms of tender from the [illegible] Mr. [illegible] W. Eloxam, East Bridge-st., Belfast. [illegible] the Town Clerk, City Hall, Belfast, by 10 a.m. March 13.

[illegible] Guardians require tenders by noon March 13 for [illegible] electric fittings, ironmongery, oils and [illegible]. Forms of tender from the Master of the Workhouse.

Tenders are required by first post March 18 for six or 12 months' supply of electrical goods to the CHESHIRE COUNTY ASYLUM, Parkside, Macclesfield. Forms of tender from the Clerk of the asylum.

WESTMINSTER Guardians require tenders by noon March 20 for six months' supply of electric lamps and fittings, engineers' sundries, &c. Forms of tender from the Clerk, Princes-row, Buckingham Palace-road, London, S.W.1.

Tramway Trackwork, &c.

MANCHESTER Corporation require tenders by 10 a.m. March 12 for (a) permanent way special track work, and (b) copper rail bonds. Specifications from the Tramways General Manager.

Appointments Vacant.

A wireman is wanted for the Essex County Asylum, Hellingly. Applications to the Resident Engineer and Surveyor. *See advertisement.*

A mains superintendent is required for the electrical engineers' department of Stoke-on-Trent Corporation. Salary £234 per annum. Applications to the Borough Electrical Engineer, St. Peter's-chambers, Glebe-street, Stoke-on-Trent.

Two experienced switchboard and sub-station attendants are required for the Salford Corporation electricity department. Applications to the borough electrical engineer, Frederick-road, Salford.

Business Items.

The British Empire Producers' Organisation has removed to 62, Oxford-street, London, W.1.

Owing to their former offices having been commandeered by a Government department, the General Vehicle Co. have removed to temporary offices at 4, Southampton-row, London, W.C.1.

The National Carbon Co. (J. R. Morris), owing to the commandeering of their offices, have removed temporarily to 50, Lincoln's Inn Fields, London, W.C. 2. Telephone Holborn 248.

Mr. Walter Langdon Davies notifies that, in order to avoid his name being confused with a conscientious objector, or with an electrical firm of similar name, he will in future sign himself as Walter L. Davies.

Plant for Sale.—An advertiser has for sale two Westinghouse d.c. generators and two oil-immersed static balancers.

Insulating Varnishes.—We are informed by Messrs. Jenson & Nicholson (Ltd.), Goswell Works, Stratford, London, E., that in order fully to protect their various insulating varnishes and compounds, they will in future be graded and classified for market purposes under the registered names of Laewatt, Cohe, Corlac, Mulac and Maimel. The goods are entirely British. Further information can be obtained from a pamphlet issued by the makers.

British Magnetos.—The British Apparatus Association has issued a neatly-printed and well-illustrated brochure giving particulars of British magnetos.

A list is given of the British firms who are manufacturing magnetos, and the information includes illustrations of the standard types and makers of magnetos for the motor trade, stationary and portable engines, &c. Readers who would like to receive a copy should communicate with the publicity department of the Association, 8, [illegible] buildings, London, E.C.4.

Calendar.—We have received from the Key Engineering Co. (Ltd.) a handy pocket card calendar for 1918, which can also be used for measuring inches, millimetres and centimetres, the scales being marked on the edges of the card.

Liquidations and Bankruptcies.

[illegible] Magnetos (Ltd.) is being wound up voluntarily, and Mr. J. J. [illegible], [illegible] House, London, E.C.2, has been appointed liquidator. A meeting of creditors will be held at [illegible] House on March 11.

A meeting to receive the account of the winding up of [illegible] Electrical [illegible] (Ltd.) will be held on March 11, at 24, [illegible], London, E.C.

[illegible]

[illegible]

[illegible]

Companies' Meetings and Reports.

London Electric Supply Corpn. Ltd.

Mr. ROBERT H. BENSON, who presided over the ordinary general meeting on the 26th ult., said that the result of the year's working showed an increase of nearly £10,000 (£9,580 to be precise) over the previous year. That was due partly to increase of price received for current sold (£217,478 as compared with £212,328) and partly to decreased cost of generation (£119,961 compared with £127,897) and it was a result with which, in these difficult times, the Board were satisfied. A year ago, faced as they were with increasing difficulties of every sort—with a 150 per cent. rise since 1914 in the price of coal, and 75 per cent. in the cost of labour—it would have seemed over sanguine to expect to be able not only to maintain, but to increase their preference dividend from 4 to 5 per cent., and to add to the carry forward the £2,000 taken from it last year. There was still 1 per cent. more to be earned before the preference stock got its due, viz., 6 per cent., and, of course, as usual, there was nothing for the ordinary stockholders of that, the oldest of the London Electric Supply Companies. Nevertheless the result gave encouragement to a gallant and long suffering body. The measure of improvement and success was due to the untiring devotion and resources shown by their staff, to whom it would be a pleasure once more to convey their warmest appreciation of what they all owed to their services. If, in the fourth year of universal war, they had been able to more than hold their own, he believed they might without undue optimism look forward to the future of the Corporation when once normal conditions were re-established. Only one thing was needed—a relaxation of the shackles with which, in the imaginary interest of the consumer, the development of power production had been confined from the beginning. To reach, without predudice, the true and just solution of this great question, viz., cheap power freely obtainable for productive and reproductive purposes after the war, they must look at it historically. The first Act of Parliament regulating the production of electrical energy was Mr. Joseph Chamberlain's Act of 1882, which took such care of the interests of the consumer that capital could not be raised under it. Notwithstanding that, a start was made privately in 1885 to supply the public with the boon of electrical energy. Four years later came the Act of 1888 under which all the London Companies were formed and now work. The loss of the pioneers—your loss—had been public gain. That history—which can be read in full in the life of Lord Wantage, was relevant to-day because it illustrated the root of the trouble—the real reason why London was slower in getting a supply of cheap power than any other centre of the world. Looking back and reading the lesson of history it was easy to say now that two mistakes were made: (1) Parliament forbade the London companies to amalgamate for the purpose of cheaper production. (2) Parliament reserved an option of purchase now vested in the L.C.C. on the basis of a break-up valuation of the plant in 1931, and no man could say how that valuation would work out. With such uncertainty ahead, when it was necessary to borrow money to pay for more turbines, dynamos, mains, &c., to meet the public demand for more power, a London company could not offer a security that was certain to be repaid in 1931. Was it good public policy to keep power companies poor, checking their development in order to have the option of buying them up cheap? The difficulty increased as the day approached. Instead of first-class up-to-date plants, the L.C.C. might end in finding only antiquated plant to buy up. But it was not too late. The general principle of the report on Electric Power Supply by the Coal Conservation Sub-Committee, suggested the formation of new authorities for the generation and distribution of electric supply from large power stations, economically and conveniently situated throughout the country, instead of continuing the present uneconomical system of supply from a large number of stations, the majority being small, out of date, inconveniently situated and extravagant in working. The suggestion was not a new one. As far as London was concerned ten years ago, in 1905, the London Electric Supply Corporation promoted a Bill in Parliament for [illegible] [illegible]

[illegible]

power contracts. The increase in wages since the war started amounted to 75 per cent. compared with 1914. The cost per unit sold was about the same as last year, viz., 0·79d., against 0·80d.; while the average price received showed a slight increase, viz., from 1·02d. to 1·06d. per unit.

The resolution was carried unanimously; the retiring director (Mr. Oliver Bury) was re-elected, and Messrs. Gane, Jackson, Jeffreys & Freeman were also re-elected auditors.

St. James' & Pall Mall Electric Light Co. (Ltd.)

Mr. WALTER LEAF, who presided over the ordinary general meeting last week, stated that the report for last year was a highly satisfactory one, showing an increased revenue, large profits and an increased dividend with appropriation to contingency fund, as well as a large addition to the amount carried forward. When they declared in July the increased interim dividend there seemed to be good hope that they should have no difficulty in paying their regular 10 per cent. The situation changed, and by no means for the better, with the turn of the year. Their revenue had been a "record" one. The outputs in units increased by over 700,000, and the revenue by over £17,000. A large part of that came from the addition to their charges to customers, made in September, 1916, of 10 per cent., to meet the increase of cost due to the war. They were every year becoming more and more dependent on the Central Electric Co. for the generation of energy, and using their own stations more and more for transformation only. The Central Company was, in fact, the backbone of their business, as well as of that of their friends and allies, the Westminster Company. Last year he referred to their order for a 6,000 kw. turbo-generator which in the course of construction was [illegible] by the Government. He would like now to acknowledge the readiness with which permission had been given them, under altered circumstances, to obtain a precisely similar set, which was in course of erection at Grove-road, and would soon be complete. The purchase of the new unit, together with some important additions which they were hoping to make to the Grove-road station, they proposed to provide for by a loan from the two parent companies in equal shares. So long as their main business was the supply for lighting they could forecast from [illegible] of the year an approximate curve for the output of the 12 months, since the chief element was the time of sunset, a quite known datum, only subject to disturbance by such factors as the introduction of "summer time." But there had been a new and striking development of their business in the last two years—in the rapid and continuous growth of the demand for current for heating purposes. They were now largely dependent for a substantial part of their revenue on that very uncertain instrument, the thermometer. The cold spell of 1917 extended over the greater part of the first quarter, but this year it was confined to the first three weeks, since when the weather had been exceptionally mild. They must calculate on a smaller revenue for the year. But what caused them more apprehension than the probable falling off in revenue was the certain increase in expenses, particularly [illegible] that of war allowances to employees. They were, and always had been, on the best possible terms with their men. During the war they had fully recognised their claims to war bonus, and it had been their policy always to anticipate any demands on their part by offering [illegible] any request had been made by them. The plan had worked excellently. At the beginning of January, however, outside influences caused the Government to extend to the electrical industry the $12\frac{1}{2}$ per cent. bonus on earnings originally granted to certain skilled time-workers in munition works. It was estimated that the effect of the $12\frac{1}{2}$ per cent. bonus, together with advances already given by the board in the course of 1917, would be to increase the cost of their war allowances in 1918 by some £6,000, and the total expenditure was [illegible] increase of from £10,000 to £12,000. Mr. Walker's [illegible] trouble in the [illegible] toward the end of December, and he advised—and fortunately they followed his advice—that notice should [illegible] further rise in the charges of 10 per cent., to become [illegible] of the March quarter. That they could do without [illegible] of 8d. per unit.

Mr. MARLBOROUGH R. PRYOR seconded the motion for the adoption of the report, which was carried unanimously, and the retiring [illegible] re-elected.

Westminster Electric Supply Corpn. (Ltd.)

[illegible] the CHAIRMAN (Mr. J. [illegible]) moved the adoption of the report and accounts [illegible] for 1916 [illegible] increased by [illegible] the report old for [illegible] That had [illegible]

Forces, and also of the way in which the remainder had met the increased work which they had consequently been called upon to perform.

increased considerably, due to increased war bonuses given to their employees to meet the high cost of living and to donations to war funds. Several Committees appointed by the Government had of late been considering and enquiring into "after the war" conditions, and among the subjects discussed, that of the supply of electricity had been prominent. So far no practical conclusions had been arrived at, and he need only say that they would carefully watch any developments. They proposed to place £7,500 to reserve and also to carry forward a substantially increased balance. He desired to express their high appreciation of those members of the staff who are, or had been, with the Forces, and also of the way in which the remainder had met the increased work which they had consequently been called upon to perform.

Capt. EDMUND I. BAX seconded the resolution, and referred to the greatly increased number of units used last year for purposes other than lighting, especially with regard to heating. That system had lagged behind for many years, and he had been disappointed at the slow way in which it had developed; but last year, owing, no doubt, to the restricted allowances of coal made to householders, they had been almost inundated by demands for heating. They had not, however, been able to supply everybody who had called for power for that purpose, first because it frequently necessitated a new service, which meant copper, and that was very difficult now to obtain, and secondly because they had felt obliged to keep in reserve sufficient machinery to supply the great calls made by Government departments for all the new Government offices which they saw going up all round them. Frequently when people said that they must have electric heating and that they would be satisfied with a small supply, they had given them a small service, and it often occurred that people came there and said that they were disappointed with electric heating—that they did not get the heat they expected to get out of it; but that was merely because they do not make an intelligent use of electric heating. People installed a heater of very small capacity, but if they would only use it intelligently and install a heater of, say, 4 kw., they would find it to be really quite an economical method of heating if used in a proper manner. It was not economical if it was burnt constantly, but in a room in which it was only occasionally used, such as a dining room or a bath room, it was not only exceedingly comfortable and had many advantages over other fires, but was also extremely economical, because it only needed to be turned on to the full for 10 minutes or so before a meal was required, and after you had been in the room for a quarter of an hour you could turn off half or more of it, and get quite enough heat in the room to last throughout the meal. The current for that purpose would not cost more than about 7d. per day, and would give all the heat required during all your meal hours. They might now say that electric heating was really making a move in the right direction. Their consumers included about 2,300, who among them were using about 6,000 electric fires.

The motion was carried unanimously. Lord Kinnaird, K.T., and Sir Edward Goulding, Bart., M.P., were re-elected directors, and Messrs. Jackson, Pixley & Co. were also re-elected auditors.

Telegraph Construction and Maintenance Co. (Ltd.)

At the fifty-fourth ordinary general meeting last week, the chairman (the EARL OF SELBORNE, K.G.), in moving the adoption of the report and accounts, said that they were going to increase the reserve fund again. The item of "by property, consisting of freehold and leasehold premises, machinery, plant, stocks of stores, materials, &c.," was £502,000 odd against £327,000 last year. That means they were holding a larger stock of raw materials, and, of course, the cost was constantly increasing. The amounts owing to the Company were £382,000 against £477,000. Last year they had less raw material, and they had completed more orders, for which they were awaiting payment, and this year the position was rather reversed. The principal feature in the report and balance sheet before them was that the accounts for 1917 showed a larger net profit than in the previous year, although they had met the depreciation on their investments this year out of revenue in our usual way, instead of drawing upon the reserve fund for the purpose, as they had to do last year. The increased profit was accounted for by a larger output and a bigger turnover. They had been very busy all the year working day and night to meet the demands made upon them, and with the larger amount of work done there had not unnaturally followed an increase in the profit for the year. At the outbreak of the war they were called upon to do munition work. It involved a good deal of alteration to their machinery and plant and method of working. That work, in consequence, was at first not very remunerative, and their profits for the first two years of the war fell short of their pre-war standard, but now they had got into their stride with that work, and the result was a better output with more satisfactory results. They proposed to distribute the same dividend and bonus as last year and again to build up the reserved fund by £20,000, and to add £10,000 to the staff pension fund. This fund was started in 1898 with a contribution of £5,000; a further £5,000 was added in 1899, in 1900 £10,000; and £20,000 in each of the two following years, but since 1902 nothing further has been contributed to that fund. They thought that after the war the need of this fund would be pressing. Their younger men had gone in large numbers to [illegible] and the men who perhaps would have retired had continued giving their best service to the Company under the circumstances, and he was quite sure that when the time came for their retirement it would be their wish that their directors should deal with them generously.

Sir JAMES PENDER, Bart., seconded the resolution, which was carried unanimously.

The Earl of Selborne, K.G., and Sir James Pender, Bart., the retiring directors, were re-elected, and Messrs. Deloitte, Plender, Griffiths & Co., and Messrs. Gane, Jackson, Jeffreys & Freeman were appointed auditors.

ABERDEEN SUBURBAN TRAMWAYS CO.—At the meeting last week it was reported that, although more people were travelling, the higher cost of materials, wages and other abnormal circumstances made the profit for the six months £1,164, compared with £1,595. There was little prospect of an immediate improvement, and the directors might have to increase the fares.

AUTOMATIC TELEPHONE MFG. CO. (LTD.)—The net profit for 1917 was £44,376 after providing for excess profits duty. A dividend of 6 per cent. was proposed on the ordinary shares. A sum of £14,000 has been written off properties and £11,550 carried forward.

BLACKPOOL & FLEETWOOD TRAMROAD CO.—The report for 1917 states that the balance of revenue brought forward from 1916 was £3,750, and the net earnings for the year (after payment of debenture interest and fixed charges) were £18,408 making a total of £22,158. The interim dividend for six months ended June 30, at rate of 4 per cent. per annum, absorbed £3,000 leaving £19,158. The directors recommend payment of final dividend of 4½ per cent. (making 6¼ per cent. for the year) on the share capital, absorbing £6,750, placing to general reserve £2,000 [illegible] 10s. 2d.

COUNTY OF DURHAM ELECTRIC POWER DISTRIBUTION CO. (LTD.)—[illegible] 1917 [illegible] Supply Co.), amounted to 122,540 H.P., compared with 104,104 H.P. in 1916, [illegible] and adding balance from 1916 (£3,530) the total is £62,651, against which has been charged interest on loans and debenture stock (£12,511), leaving £50,140. The directors recommend payment of a dividend of 9 per cent. [illegible] £112,472 [illegible]

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.)—The directors recommend [illegible] cent. per annum (less tax) for the half-year to Dec. 31, 1917, making 7 per cent. [illegible]

ELECTRICAL DISTRIBUTION OF YORKSHIRE (LTD.)—At the recent meeting the chairman (Mr. R. W. Wickham) said that, despite war-time difficulties, [illegible] energy for heating and cooking by existing consumers, and the directors believed that under normal conditions the use of energy for domestic purposes [illegible] a dividend of 6 per cent. (tax free). Although increased costs had given the directors much anxiety, they had been able to maintain their supply so far without [illegible] made. The company were now the undertakers for 24 electric lighting orders [illegible] sidered that it was essential to prepare for peace times, and as the capital issued in February, 1916, was now fully paid up, and additional capital would be required [illegible] that their powers to issue capital should be increased. The consent of the Treasury to a further issue could not be obtained at present, but the [illegible] delay when the present restrictions were removed. The report was adopted [illegible]

ELECTRICAL & INDUSTRIAL INVESTMENT CO. (LTD.)—The profit for 1917 [illegible]

MANSFIELD & DISTRICT TRAMWAYS (LTD.)—[illegible] 1917 [illegible] 1916. It was proposed to increase the dividend on the ordinary shares to 8 per cent. [illegible]

MATHER & PLATT (LTD.)—At the meeting last week the chairman [illegible] understanding of the different points from which situations were viewed, and the utmost integrity being shown by the management in all that affected the workers' outlook. It was too much to expect that the workers would altogether abandon restrictive practices until the employers had first given positive proof that they were endeavouring to make working conditions and the continuity of employment better than they had ever been before.

MERSEY RAILWAY CO.—The report for the year 1917 states that under the scheme of arrangement scheduled to the Mersey Railway Act, 1900, as extended by the Mersey Railway Acts, 1906, 1910 and 1915, the payment of interest on the 1866, 1871, 1882 3 5 and B debenture stocks is contingent on the revenue available therefor in each separate year after providing for the interest on the new first perpetual debenture stock. The total available for payment of interest is £48,248. 15s. 11d., and the interest on new first perpetual debenture stock is £26,775. 10s. 6d. The balance available for payment of interest on the contingent debenture stocks has been applied as follows: Interest at 4 per cent. on the 1866 debenture stock (£4,664), at 3 per cent. on the 1871 stock (£3,000), 3 per cent. on the 1882 3/5 stock (£10,800) and 1 per cent. on the B debenture stock (£2,814 6s. 10d.), leaving to be carried forward £194. 19s. 7d.

METROPOLITAN ELECTRIC SUPPLY CO. (LTD.)—The directors' report for 1917 [illegible] amounted to £2,293,094 has now reached £2,317,848, an increase of £24,754. The gross revenue for the year was £318,216 compared with £277,909, an increase of £40,307. Working expenses were £184,543 against £161,009, an increase of £23,534. The balance at credit of revenue account, before providing for depreciation, is £133,674. The directors have set aside £50,000 as an addition to the depreciation and reserve fund, which now amounts to £427,359, carrying to credit of net revenue account £83,674. This sum, with balance brought forward, interest and dividends on investments and other receipts, makes a total of £98,224. After deducting interest on debenture stocks and loans and dividend on preference shares, there remains £44,927. An interim dividend of 1s. per share (being at rate of 2 per cent. per annum) on the ordinary share capital, amounting to £10,000, was paid in August, and the directors recommend that a further dividend of 3s. per share (being at rate of 6 per cent. per annum) on such shares be now paid, making a total distribution for the year of 4s. per share, or 4 per cent. This will absorb £30,000 and leave £4,927 to be carried forward. During the year new connections, representing 1414·5 kw. were added, making a total connection at the end of the year of 40,948 kw. In order to provide additional working capital and to pay off loan from bankers, a new issue of debentures called "Extension Debentures, 1917," amounting to £500,000, [illegible] the year. Arrangements have been made for the acquisition of approximately the whole of the preference and ordinary share capital of the Uxbridge and District Electric Supply Co. as at Dec. 31, 1917, and the purchase will be completed immediately. Mr. E. Cunliffe Owen, C.M.G., who has been in the service of the Company for nearly 30 years, has retired owing to ill health, and Mr. F. Hipwell has been appointed [illegible]

NORTH STAFFORDSHIRE RAILWAY CO.—At the annual meeting last week the chairman, Lord Anslow, C.B., stated that electric track cir- [illegible]

NOTTING HILL ELECTRIC LIGHTING CO. (LTD.)—The directors' report for 1917 [illegible] equivalent of 252,307 30-watt lamps is connected (against 241,859), [illegible] (£1,516. 18s. 5d.), income tax (£4,720. 18s. 4d.), and amount to be dis- [illegible]

SOUTH LONDON ELECTRIC SUPPLY CORPN. (LTD.)—[illegible]

[illegible] system [illegible] a total connection at the end of the year of 417,740 35-watt lamps, the equivalent of 14,600 kw. The units sold during the year amounted to 7,549,945, an increase of 851,588 or 12·7 per cent. over 1916.

SOUTH METROPOLITAN ELECTRIC LIGHT & POWER CO. (LTD.)—Mr. H. St. John Winkworth, who presided over the meeting last week, stated that during the past year 126 new consumers were connected, which, together with extension orders, represented 2,494 H.P. The number of new consumers was again much less than might be expected but for the Government restrictions as to the use of material and the further restrictions in the use of supply. The price of material also remained very high, and cable extension work had been kept to a minimum in residential and shopping districts. The very stringent orders as to lighting had resulted in a further loss, but to adjust that a slightly increased charge had been made for lighting supply and the rates charged to consumers generally had been revised so as to meet in part the present high cost of production at the power house. Further work of an important character had been carried out during the year in connection with war requirements. After an analysis of the accounts of the Company and of the West Kent Co. (which was paying a dividend of 10 per cent.) he said the prospects for the present year so far as the gross revenue was concerned were favourable, as important new business, extension orders and additional bulk supply had been secured, but the delay in the delivery of plant at the power-house to meet those demands was causing delay in connecting. When the new plant was working, considerable economies would be possible and a large saving effected in coal consumption.

Mr. H. W. Bowden, who seconded the motion for the adoption of the report, said that the output had largely increased. It was 21·91 million units, against 15·41, an increase of 6½ million units. The additional output had been accomplished with difficulty, and there was a considerable increase in the cost of generation. Late delivery of machinery and plant necessitated carrying on (notwithstanding the steadily increasing load) with smaller and less efficient turbine and boiler units, long overdue for cleaning and repairs; and, owing to the shortness of boiler power, it became necessary to use considerably higher-priced fuel than hitherto, so that war conditions were largely, if not wholly, responsible for the increased consumption of fuel. The fuel bill had increased £26,600 (from £26,600 to £53,400). The increased output of 6½ million units accounted for about £9,300, and the increased price, freight, &c., accounted for £17,500, when the larger machines and boiler units were in continuous and successful operation he estimated that the saving in fuel would be at least £150 per week. On the distribution side good work had been accomplished in the laying of a new E.H.T. feeder to Crayford, and the erection of a further extension sub-station, the total capacity of which is approximately 5,000 k.v.a. The efficiency of distribution had again improved, being 87·1 per cent., against 84·39 per cent., which was largely accounted for by the bulk power units to the West Kent Co.

TRAMWAYS, LIGHT & POWER CO. (LTD.)—Viscount Chilston, who presided over the meeting last week, said that their income, which was derived from the various power, light and tramway undertakings owned by them, amounted to £42,215, compared with £35,272 for the previous year. The administration expenses were £1,100 greater than for the previous year, and the available balance was £39,274, compared with £33,420 for 1916. Their total investments (representing entirely debentures and shares of the power, lighting and tramway companies) stood at £[illegible], compared with £780,638. The increase represented the amount spent during the year on their various properties. The actual increase in [illegible] profit for the year by the underlying companies was really [illegible] than shown by the accounts presented, as the directors of those companies had [illegible] £[illegible] more than in the previous year. The [illegible] depreciation fund and carry forward in the underlying companies [illegible] to £40,[illegible] They knew the great strain [illegible] upon the management of public utility undertakings [illegible] that they should express their indebted[ness] [illegible] services, [illegible] The total sum they had [illegible] brought forward, [illegible] paid [illegible] debenture [illegible] £3,000, interim [illegible] The directors [illegible]

[illegible]

[illegible]

and the Associated Equipment Co. The issue of 4½ per cent. three-year notes matured during the year, and a new issue of £700,000 5 per cent. three-year secured notes was made on March 30, 1917, and the maturing notes were paid off. The London Electric Railway Co. provided the necessary rolling stock for the through running of trains from the Bakerloo section of the railway to Watford on the electrified portion of the London & North-Western Railway. The through service commenced on April 16, 1917, and traffic is developing satisfactorily.

New Companies.

TEES POWER STATION CO. (LTD.) (149,607.)—Reg. Feb. 13, capital £700,000 in £1 shares, to acquire from the Newcastle-upon-Tyne Electrical Supply Co. some freehold land at Billingham, to erect thereon a generating station for electrical energy, to erect any similar stations elsewhere, to enter into an agreement with the said Newcastle Company or any of its associated companies for operating the said station or stations, to utilise and sell gases, waste heat and other products, to supply electrical energy, to construct, lay down and fix cables, wires, motors, lamps and works, to carry on the business of electricians, mechanical engineers, &c. First directors are J. H. Armstrong and R. P. Sloan. Reg. office: Royal Exchange Buildings, Newcastle-on-Tyne.

WHITE ELECTRICAL INSTRUMENT CO. (LTD) (149,605.)—Private company. Reg. Feb. 12, capital £10,000 in £1 shares, to take over the business of an electrical and scientific instrument manufacturer, carried on by Kate I. B. White, at Gloucester-street, Clerkenwell, as the White Electrical Instrument Co. First directors are Mrs. Kate I. B. White and C. E. Cox (managing directors). Reg. office: 2–4, Gloucester-street, Clerkenwell, E.C.

City Notes.

BOURNEMOUTH & POOLE ELECTRICITY SUPPLY CO. (LTD.).—The directors recommend a final dividend on the ordinary shares at the rate of 7 per cent. per annum (less tax) for the half-year to Dec. 31, making 6 per cent. for the year.

BRAZILIAN TRACTION, LIGHT & POWER CO. (LTD.)—The directors have declared a quarterly dividend of 1½ per cent. on the fully-paid cumulative preference shares, payable April 1.

BRITISH INSULATED & HELSBY CABLES (LTD.)—The directors have declared a final dividend of 7½ per cent., together with a bonus of 10 per cent., making 25 per cent. for the year 1917, against 20 per cent. for 1916.

DAVIS & TIMMINS (LTD.)—A balance dividend has been declared on the ordinary shares at the rate of 10 per cent. per annum, making 8 per cent. for the year 1917, together with a bonus of 17 per cent., tax free.

The Round Table.

By "kVA."

Problem of the Moment.—The salesman of electrical plant who has left his meat ticket at home and who is entertaining a good prospective customer who has done the same!

* * *

From an evening paper:—

"Gweithredyddion diwyfrau" is a clumsy effort in the advertisement columns of the Welsh press to translate "Wireless operators."

* * *

A correspondent sends me a cutting from "Blackwood's Advertiser" of an advertisement of the British Commercial Gas Association. In the centre is an illustration showing a "Distinguished Architect" discussing with a client the plans of his new house, which is to be a "regular gas house—what?" The client suggests gas for lighting and the architect vigorously replies "Certainly, certainly! I should advise inverted incandescent gas lights, with nice silk shades. Better for your eyesight and keeps the air circulating in the rooms . . . . more hygienic." Unfortunately the artist did not play up to these sentiments, for the architect's office is lighted by an unmistakeable three-light *electric* pendant!

* * *

Thirty-Seven Years Ago.

[From The Electrician, March 5, 1881.]

[illegible] The Brush Electric Light [illegible] to accomplish during the recent [illegible] sitting in the [illegible] a feat hitherto without a parallel in the annals [illegible] They lighted Westminster Palace yard for [illegible]

[illegible] The good folk of Penzance have begun to [illegible] per 1,000 ft. [illegible] the price of the illuminant. At a [illegible] meeting of ratepayers and consumers statistics were [illegible] that 3s. per 1,000 ft. would be a fair price [illegible] If these figures be correct we can only wonder that the Penzance folk did not kick long ago.

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

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CONTENTS.

Notes.

The Trade Marks Bill.

We commented recently upon the draft Bill to amend the Patents and Designs Act and drew attention to certain aspects which required greater consideration. There is, further, a projected Bill to amend Trade Marks Act, 1905, and a perusal of this shows that at least one portion thereof is open to serious objection. In recent years the practice has grown of branding certain articles with a trade mark which, in the eyes of the public, has become identified not merely with the particular article bearing the trade mark, but with the class to which this article belongs. Perhaps the best examples are to be found in drugs. Whether the process is part of a shrewd German method of getting business we do not know, but the fact remains that in many cases medicinal drugs have been introduced into this country from Germany under a trade mark. Obviously it is no use telling the general public that a certain drug which is known to the chemical world by a name of 14 syllables is good for [illegible] [illegible] be remembered. On the other hand, [illegible] conveniently [illegible] the popularity [illegible] [illegible] the same drug under another name. The proper procedure [illegible]

A Drastic Proposal.

In the draft Bill now under consideration it is proposed that trade marks so used may be removed from the register. This suggestion, however, introduces serious complications. In many cases it is very difficult to prevent the public from calling articles by their trade marks. It is true that if the proprietor of such a trade mark "has not by advertisement or otherwise encouraged, and has taken all reasonable steps to prevent," the use of his trade mark in this way it will not be removed from the register; but it appears to us that this safeguard introduces a very difficult position. The point arises more particularly when some new product is placed on the market. It is then very natural that the product should be known by the trade mark, and it may be some considerable time before any competitive product of the same kind is available. It seems to us that a more reasonable stipulation would be that, in the event of more than one trade mark being registered for the same product, the label on such products should then bear the recognised trade name of the product, in addition to the trade mark. As it is, we are afraid that the Bill will cause much difficulty and considerable harm to some of our manufacturers. This is the view of the Federation of British Industries, the London Chamber of Commerce and many other Chambers of Commerce, and we understand that it has given rise to much uneasiness in commercial circles in the United States. That being so, we feel that our manufacturers should oppose the Bill as a whole unless this particular section is removed or modified.

Electric Power and Heating Stations.

As we went to press last week an interesting pamphlet came to hand from Mr. W. M. Selvey suggesting that electric power stations might do well to include the supply of hot water among their activities. For this purpose steam would be taken from the low-pressure stages of the turbines, so that the condensed steam would have a temperature of about 140 F. This would be pumped through a main of, say, 12 in. diameter, from which it could be drawn off, or it might pass through domestic heating appliances, and would then find its way back to the station through return pipes. It is pointed out that heat energy can be divided into high-grade heat and low-grade heat, the high-grade heat being used in the turbines and the low-grade heat being rejected. The scheme is certainly [illegible] pipe is a small proportion of the heat transmitted, provided the water is kept moving above a certain rate. At times, however, [illegible]

that the tendency in future will be for the power station to be well outside the limits of a town. The general scheme is too complicated to pass any serious decision upon it without very careful investigation, but before acceptance we think that minute scrutiny would be necessary.

The London Electric Supply Companies.

It is noticeable from the annual meetings of the London electricity supply companies now being held that fuel on the one hand and war bonuses on the other are fruitful subjects of comment. They both tend to make the carrying on of such undertakings unusually difficult in these days, and inevitably lead in time to the raising of prices to the consumer. In the case of the Westminster Electric Supply Corporation, restrictions on coal have led to much activity in the supply of electric radiators, there being now about 6,000 electric fires distributed among 2,300 consumers. Capt. E. I. Bax, in addressing the shareholders, called attention to a fruitful cause for dissatisfaction in the use of radiators—namely, the tendency to put in too small a heater for the purpose. From the point of view of effective heating, it is much better to use a large heater, which is then partially cut off when the required initial warming has been effected. We are glad to note that the change in policy of the Metropolitan Electric Supply Co., as the result of the Committee of inquiry, has been beneficial, and that there is a pronounced improvement in the revenue, coupled with expansion on the power side. At the meeting of the London Electric Supply Corporation, Mr. R. H. Benson mentioned that the average price received per unit was 0·94d., and the average price of energy sold for power was under ¾d. per unit. He also questioned the desirability of the policy which checked the growth of an electricity supply company in such a way that the L.C.C. would eventually find only antiquated plant in its bargain. It is to be hoped that this policy will be entirely altered in the near future through the deliberations which are now taking place. The policy now favoured is one of amalgamation, and it is odd to think that only 10 years ago, when the London electric supply companies promoted a Bill in Parliament for amalgamating their undertakings and for working them on the lines generally laid down in the report of the Coal Conservation Sub-committee, Parliament refused [illegible]

Communal Kitchens.

[illegible] there is a strong movement in favour of communal kitchens, partly because these enable the poorer [illegible], and partly because they [illegible]. In this class of work there [illegible] opportunity for electric cooking. We need not emphasise the fact, which is well known to our readers, that [illegible] have proved eminently successful in [illegible] and otherwise. So far, however, [illegible] that not very much has been done in the [illegible]. We think it desirable to [illegible]

Electrical Work in the Navy.

The subject of electrical equipment in the Navy, we need scarcely say, becomes increasingly important as time goes on. Some years ago it was looked upon merely as a side line. Then came the appointment of Mr. C. H. Wordingham; but even after this appointment, and up to the present time electrical engineering has been regarded by many people only as a branch of naval construction. Now, however, we are glad to note that Mr. Wordingham's title has been changed from Superintending Electrical Engineer to Director of Electrical Engineering, and his department has been made an independent one, instead of a branch of the Department of Naval Construction. We are glad that this should be so, for it is thus evident that the work carried on by Mr. Wordingham in the past is valued and that electrical engineering in the Navy is now regarded as of prime importance.

Junior Institution of Engineers.—Sir Charles A. Parsons, K.C.B., F.R.S., has accepted election as vice-president of the recently inaugurated North-Eastern Section of this Institution.

Institute of Radio Engineers.—Owing to the stress of war work, meetings of the Institute are to be suspended except on special occasions, as the editor has found it extremely difficult to secure new Papers with regularity.

Physical Society.—The fourth Guthrie lecture will be delivered on Friday, the 22nd inst., at 5 p.m., at the Imperial College of Science and Technology, South Kensington, by Prof. J. C. MacLennan, of the University of Toronto. His subject will be "The Origin of Spectra."

Royal Society.—Among the 15 candidates recommended for election to the Royal Society is Mr. F. E. Smith, of the National Physical Laboratory. His work is well known to our readers. It is curious that no other representative of physics appears, either in pure or applied, nor is there any representative of engineering. Among the chemists may be mentioned Prof. H. C. H. Carpenter.

Scattering of Light by Dust-Free Air.—At a recent meeting of the Royal Society the Hon. R. J. Strutt read a Paper showing that, by proper arrangement of the experimental conditions, it is possible to observe the scattering of light by pure air, free of dust, in a small scale laboratory experiment. The scattered light in air and in all the other gases is blue—the blue of the sky—illustrating very directly the theory that attributes the blue of the sky to scattering by the molecules of air. The scattered light is almost completely polarised.

Lighting Curtailments in the United States.—We observe that at a meeting of the Illuminating Engineering Society in the United States on February 14th a Paper was read by Mr. Preston S. Millar on "Lighting Curtailments." Representatives of the American Institute of Electrical Engineers, the American Gas Institute and the Fuel Administration were invited to join in the discussion. There is much to be learned from the methods employed in the United States in dealing with the fuel problem, and we shall await the account of this discussion with much interest.

Corrosion of Muntz Metal.—A new publication of the Bureau of Standards, Washington (Technological Paper No. 103), deals with "Typical Cases of the Deterioration of Muntz Metal (60:40 brass) by Selective Corrosion." The selective corrosion is illustrated by four types, including tubings, sheets and forgings. The metal becomes red in colour, very weak and brittle by this type of corrosion. The condition favourable to such corrosion is the accelerating effect of the closely adhering deposits of chloride resulting from the attack of the metal. Other conditions accelerate the corrosion, such as contact with the more electronegative constituents, increase in temperature and severe stresses. The Paper can be obtained by those interested on application to the Bureau.

Rontgen Society.—At a meeting of the Rontgen Society on March 15, Mr. C. R. C. Lyster and Dr. S. Russ read a Paper entitled "A Biological Basis for Protection against X-Rays." An attempt was made to measure the total radiation received by an operator during a [illegible] day's work, by the aid of a photographic plate carried on the person of the operator. The density of the image, when developed, is compared with a "biological basis plate" exposed under standard conditions of radiation. The effect of hard and soft radiation (12" spark to 2") was studied; both have the same photographic effect for a given ionising effect, but the same form of plate should be used in all investigations. Mr. H. C. Head described a mobile motor X-ray unit used in Mesopotamia, current being derived from a dynamo run by a small motor engine, and a battery of accumulators. A tent is erected at one side of the car, and it is unnecessary to remove the coil or switchboard for use. The Röntgen Society has founded an annual lecture in memory of its first president, the late Prof. Silvanus P. Thompson. The first "Silvanus Thompson Memorial Lecture" will be delivered by Prof. Sir Ernest Rutherford, F.R.S., at the next meeting of the Society, on Tuesday, April 9, at 8 p.m. Applications for admission cards should be made to the hon. secretary of the Society, Dr. S. Russ, Middlesex Hospital, London, W. 1.

Institution of Electrical Engineers—Western Local Section. The seventh annual and second ordinary meeting of the session was held at the Merchant Venturers' Technical College on Monday, March 11, 1918. Mr. H. I. Rogers, in the absence of Mr. R. Howard Fletcher, presided over a well-attended meeting. Mr. W. A. Chamen, prior to the reading of Mr. Wedmore's Paper, alluded to the death of Mr. W. [illegible] and proposed a resolution of sympathy with his mother [illegible] in her bereavement. This was seconded by Prof. D. Robertson and adopted. Mr. E. Basil Wedmore gave his Paper on "The Control of Large Amounts of Power," and a very sustained and interesting discussion followed. The report of the ballot scrutineers was received, the committee for the ensuing session being as follows: H. I. Rogers (chairman), A. Ellis (vice-chairman), A. Nichols Moore, T. E. Lewis, I. A. D. Pedler, J. G. Eastwood and W. T. Kerr. Messrs. A. J. Newman and O. T. Allan were elected joint hon. secretaries, and Mr. A. J. Newman as hon. treasurer.

Coke Firing.—In the current issue of "A Thousand and One Uses for Gas" there is an interesting article by Mr. E. W. L. Nicol on "National Fuel and Food Supply: The Function of Gas Coke."

[illegible]

[illegible]

[illegible]

Obituary.

[illegible]

Personal.

[illegible]

Mr. Wadeson, who was formerly engaged with Mr. W. M. Selvey, consulting engineer, of Sheffield, has been gazetted captain.

Lieut. R. L. Acland has been gazetted major, commanding the Derbyshire Motor Volunteer Corps. [illegible]

Mr. C. H. Wordingham, M.Inst.C.E., whose official title under the Admiralty has hitherto been Superintending Electrical Engineer, will in future be known as Director of Electrical Engineering, and his department will no longer [illegible] of Naval Construction, but be entirely separate and self-contained.

Arrangements for the Week.

FRIDAY, March 15th (to day).

INSTITUTION OF MECHANICAL ENGINEERS.

6 p.m. At the Institution of Civil Engineers, Great George-street, Westminster, London, S.W. Papers on "[illegible] Women in Munition Factories," by Miss [illegible] and Mr. B. H. Morgan.

JUNIOR INSTITUTION OF ENGINEERS.

7.30 p.m. At 39, Victoria-street, Westminster, London, S.W. Paper on "Organisation of British Engineering Industry," by Mr. H. R. Summers.

JUNIOR INSTITUTION OF ENGINEERS (MIDLAND SECTION).

7.15 p.m. At the Imperial Hotel, Temple-street, Birmingham. Third Cadet Lecture on "Power Transmission," by Mr. G. H. Ayres.

SATURDAY, March 16th.

ROYAL INSTITUTION.

3 p.m. At Albemarle-street, London, W. 1. Lecture on "Problems in Atomic Structure," by Prof. Sir J. J. Thomson, P.R.S. (Lecture V.)

JUNIOR INSTITUTION OF ENGINEERS (NORTH KENT SECTION).

[illegible]

MONDAY, March 18th.

[illegible]

WEDNESDAY, March 20th.

ROYAL SOCIETY OF ARTS.

[illegible] "Agricultural Machinery," by Mr. F. S. Courtney, M.Inst.C.E.

[illegible] Paper on "The Control of Large Amounts of Power," by Mr. E. B. Wedmore.

[illegible] by Mr. H. W. Clothier.

THURSDAY, March 21st.

[illegible]

FRIDAY, March 22nd.

[illegible] Thomson, P.R.S.

[illegible]

Tests on Oil Switches.*

By BRUNO BAUER.

The previous reports are concerned with the electrical energy of the arc produced when breaking a circuit, called the "switch energy," and the means to be adopted for its diminution. The conclusions have not found universal acceptance, and in particular the tests published by Stern and Biermanns † have been held to conflict with the conclusions arrived at as to the effect of phase displacement. This question will form the subject of a later report, in which it will be shown that the tests referred to really corroborate the results in the earlier reports.

The present report deals with the thermodynamic and chemical processes associated with the operation of switching off a load. The tests were carried out partly with a special test switch at the power station in Beznau, and partly on a small scale with a switch that enabled pressure and explosive effects to be studied without danger.

The large switch consisted of a closed cylindrical pressure chamber 700 cm. long and with an internal diameter of 38.4 cm., having two insulators fitted vertically above each other in the two ends of the cylinder. These insulators supported the switch contacts, and a movable rod passed through the lower insulator. A balanced cross-arm transmitted the motion to the switch. By altering the balancing weights the velocity of the switch could be varied between 30 and 100 cm./sec. The only movable part inside the oil chamber was the rod, so that the oil should be disturbed as little as possible by the motion of the switch parts. The switch was designed for 200 amperes and 35,000 volts, and the cylinder could withstand a pressure of 20 kg. cm.^{2}.

The small switch was used for tests that were dangerous to perform on a large scale, and was used mainly for tests on ignition and explosion. The oil container was a glass cylinder of 10 cm. internal diameter, and the arc was formed between horizontal electrodes at the bottom. The opening of the switch contacts was limited to 1 cm., and in order to get comparatively large switch-energy with this small length of arc very small switch velocities were used. The tests were made with continuous current. The capacity of the switch was 100 amperes at 250 volts.

The electrical measurements and oscillograms were obtained as described in the first report. The pressure inside the oil-containers was measured by a new device. This is usually measured by gauges that cannot respond to the extremely rapid pressure variations that occur. The instrument employed consisted of a pile of carbon discs included in an electric circuit, and exposed to longitudinal compression by the pressure in the container. The variation of pressure was determined from the variation of current in the carbon pile as recorded by an oscillograph. This instrument rendered possible the measurement of rapidly fluctuating pressures.

[illegible] be examined after it has operated it will be found that the contacts at the break are burned at the point where the arc starts. The oil in the immediate neighbourhood is rendered turbid by particles of carbon. Gas has collected under the cover of the container. During the breaking of the circuit the oil is subjected to a violent shock, and some may be projected out of the container. [illegible] apparently warm after a series of operations, [illegible] that the heat transmitted to the inactive portions of the oil is small. Thus, it appears that the heat units [illegible] are distributed mainly into the [illegible] heat units for heating, volatilising and fusing the electrodes; (ii.) heat units for the chemical dissociation [illegible] for external work done by [illegible] of the unit of work and p [illegible] of the sphere of gas [illegible] the relative magnitudes [illegible] will be examined [illegible]

[illegible]

[illegible]

† [illegible]

Approximate calculations lead to the conclusion that the heat units required to dissociate the oil are small compared with the heat units that go to heat the electrodes, but the quantity and nature of the gases formed are of considerable interest. The tests showed that the volume of gas produced was approximately proportional to the switch-energy ($A=CI_0Et_e$),* and averaged 46·5 cm.^{3} of gas at 1 atmosphere and 25°C. per kilowatt-second of switch energy. Taking, as before, the "interrupted load" as I_0E (the product of the current at the moment of breaking and the open circuit voltage) and remembering that the time of duration of the arc, t_e, is nearly independent of the interrupted load, if this is greater than 5,000 k.v.a., we are able to make an approximate calculation of the switch energy and gas production per kilovolt-ampere of "interrupted load" on short circuit. For such a case we may take $C=0·07$ with a switch velocity of 100 cm. a second, and obtain the following figures:—

Voltage E.	Duration of arc t_e.	Switch-energy per 1,000 k.v.a. in kw.-sec.	Gas volume (cm.^{3}) per 1,000 k.v.a.
10,000	0·120	8·4	390
15,000	0·175	12·2	570
20,000	0·211	14·8	690
30,000	0·332	23·1	1,080

The volume of gas produced at each operation is small, but it may suffice to make an explosive mixture with any air that is imprisoned inside the oil container.

In order to determine the nature of the gases produced they were cooled to low temperatures to distil out any higher paraffin hydrocarbons (propane, butane, &c.), the unsaturated hydro-carbons (propylene, butylene, &c.), and the aromatic hydrocarbons (benzol and its homologues).

It was found that at the temperature of the room (20°C.) neither oil vapours nor other hydro-carbon vapours were present in the switch gases.

A quantitative analysis of characteristic samples of gas collected in a container from which the air had been driven out by nitrogen gave the following result for the combustible constituents:—

	Volume in per cent.	
Hydrogen	79·7	66·6
Methane	0·6	4·7
Heavy hydrocarbons (ethylene)	19·7	28·7
Total volume	100·0	100·0

Further tests revealed the presence of about 2 per cent. of oxygen and 5 per cent of nitrogen, probably originating from the breaking up of the molecules of the oil.

A series of tests on the same oil proved that the gases produced were always of about the same composition for the same switching operation.

The predominance of hydrogen and ethylene is the main feature of the above investigation, and it appears probable that the hydrogen content increases in some measure with the magnitude of the switch energy.

As far as the oil is concerned it was found by filtration that the darkening of its colour after lengthy use was due to the presence of carbon particles. By careful filtration it is possible to restore to the oil its original colour and insulating properties. This indicates the probability that the oil is not appreciably altered in its composition in use, and this presumption is confirmed by analysis of samples of new and used oil. The oil is merely changed by the mechanical admixture of carbon. It is important to note that after proper drying and cleaning the dielectric properties of the oil are the same as when the oil was new.

At the moment of the first opening of the switch contacts the thin layer of oil between the contacts is vaporised by the heat developed, and a sphere of gas is generated that provides a space for the development of the arc. This sphere increases by heating, and by the generation of more gas and, although the gas volume is acted upon by external forces, mainly in an upward direction, yet its motion relatively to the contacts is small, and so the rupture of the arc is mainly determined by the electrical constants of the circuit. Thus, it is a fallacy to assume, as is often done, that the arc has to puncture a thickness of oil at each half period.

The energy contained in the gas envelope surrounding the contacts is of vital importance to the process of switching off. The pressure developed sets the oil in motion, and may even deform the oil container. It is also possible that the heated gases may reach

* See equation 8, THE ELECTRICIAN, March 3, 1916, p. 768.

the surface of the oil while the arc is still in existence, and by mixing with the air cause explosions that give rise to new pressure variations originating at the surface of the oil.

If the gas has a mean specific pressure p and a volume V at a time t, and if the mass of the gas is G, the gas constant R, and the mean absolute temperature T, then the energy in the gas at time t may be written as

$$pV = GRT. \qquad (1)$$

As it has been shown that G is proportional to the switch energy A, we may write

$$pV = kART. \qquad (2)$$

Tests have shown that the temperature of the arc is nearly independent of the current and voltage, and if we make this assumption for the gas it follows that the energy stored in the gas at any moment is determined by the switch energy that has been developed up to that moment, and that these quantities grow together.

If the switch is quite gas tight and contains a volume V_0 of gas at pressure p_0 and temperature T_0 before it operates, and dG gram of gas are generated by the operation, then

$$p_0V_0 = GRT_0 \text{ (before the operation)},$$

and

$$p_1V_0 = (G + dG)RT_1 \text{ (after the operation)},$$

whence the change of pressure is given by

$$dp = p_0\left(\frac{T_1}{T_0} - 1\right) + \frac{dG\,RT_1}{V_0}. \qquad (3)$$

This equation shows that the volume V_0 under the cover of the oil container, increasing, as it does, with the square of the diameter if the height of the oil is constant, has a great influence on the magnitude of the pressures generated. This fact is also shown by the tests of Merriam,* in which a short circuit of 12,000 k.v.a. was broken

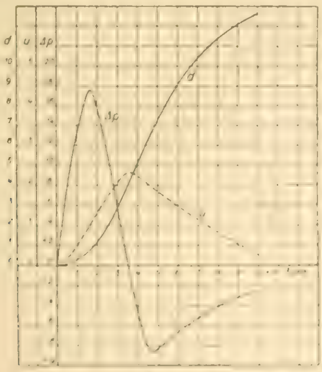


Fig. 1.

[illegible]

The agreement between the calculated and measured values is sufficient for estimating purposes. The oil containers in modern switches have much greater gas spaces (20,000 to 100,000 cm.³), so that according to equation (3) we should not expect any appreciable rise of pressure even on still heavier short circuits. In fact, a manometer fails to show any pressure rise unless the initial pressure is raised in the container; on the other hand, a test made with an initial static pressure of 12 atmospheres absolute recorded a rise of pressure of 8 kg./cm.³. The explanation of this effect requires a knowledge of the variation of the pressure during the switching period.

If the gas sphere of diameter d lies at a mean depth h below the oil, and if the static pressure at this depth is p_0 and at the surface of the oil p_a, and the pressure within the gas p, then we must have, as the gas expands, the condition

[illegible] (4)

With the aid of this equation and an assumed rate of variation of d as given in Fig. 1 we can [illegible]

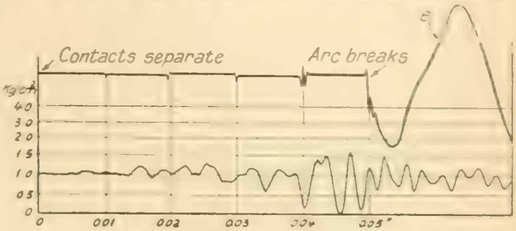
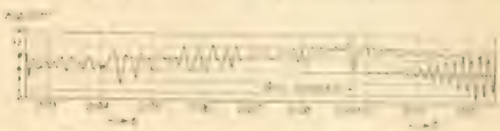


Fig. 2.—Pressure Variation Inside the Oil Container. Static Pressure = Atmospheric Pressure.

of d and the rise of pressure Δp as the first and second derivatives of the curve for p. The result shows that as a result of the forces required for accelerating the oil, the variations of the pressure in the gas may be of an oscillatory nature. It would also be expected from equation (4) that the amplitude of the pressure variation would increase with the depth of the oil. In order to test this the electric pressure gauge described at the beginning of this report was employed and Figs. 2 and 3 are two examples of the curves obtained by its use. Fig. 2 refers to the pressure in a container open to the atmosphere and Fig. 3 in one closed up and with its internal pressure raised to 6 kg. cm.² absolute. [illegible]



[illegible]

[illegible]

[illegible] as a source of fire. The small switch referred to at [illegible] of this report was tested at 80 amperes 280 volts with open container, and with the oil filled to various depths. At 45 mm. depth the contacts opened successfully, at 40 mm. smoke was emitted slightly, at 30 mm. the oil was spurted about, at 25 mm. a small flame appeared, at 20 mm. violent burning of the gases oc[illegible] 17·5 mm. the arc protruded, at 12·5 mm. the arc persisted, and at 10 mm. the arc persisted, the oil boiled and violent burning and emission of smoke appeared.

At each depth of the oil there was a certain load at which the gases began to ignite and a higher load at which the arc began to persist. Curves are given in the report to illustrate this effect. Thin oils were found to be safer than viscous ones. The switch should be built so that the best proetction is afforded with the minimum volume of oil and the use of a multiple break is a good means of preventing the explosive effects just described. The breaks should not be placed vertically above one another, but in a horizontal series.

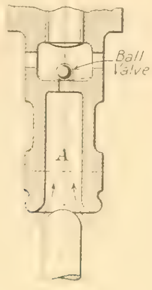


FIG. 4.

Explosions, usually causing the bursting of the container, are caused by the gas mixture that collects in the mixing space under the lid of the container, and differ in their effect from that of the gas [illegible]. The ignition may be caused either by the protusion of the arc through the oil surface or by small sparks caused inside the container by the sudden disturbance of the stationary condition of potential. A gas mixture is only explosive between certain limits of admixture with air, and its liability to explosion depends on the source of ignition, the temperature and pressure of the gas and the size of the containing vessel. A table of values is given showing the limits of admixture for which the gases produced by oil switches are explosive. It appears that the upper and lower limits of volume are of the order of 40 and 10 per cent. of the gas. The danger of explosions increases with the quantity of hydrogen present. If, in the case of an abnormal load, the oil is forced out by the chimney effect described above, the explosive limits are [illegible] with the gas mixture. Tests [illegible] mixtures of gas and oil vapour [illegible] between the limits of 0·4 per cent. [illegible] to the total volume of the mixture. The maximum intensity of burning and the greatest rise of pressure [illegible]

[illegible]

containers that can withstand the highest pressures that can occur. These methods are considered below.

The effect of the switch velocity has been discussed in the first report, and it was found that although the switch energy decreases rapidly with the velocity of the switch yet little is to be gained above speeds of about 60 cm./sec., except possibly in the case of very heavy short circuits, for which an improvement may be gained by increasing the velocity attained in modern switches. The use of a multiple-break is also referred to in the first report, and it should be noted that in addition to the reduction of the switch energy shown* to result there is the advantage that the appearance of the chimney effect is rendered less probable.

In using forced currents of oil to break the arc care must be taken that the current of oil is in such a direction as to carry the arc in a path in which it cannot accidentally strike parts of the switch, such as the wall of the container. A form of switch manufactured by Sprecher & Schuh is provided with an arrangement by which a jet of oil is directed across the contacts when they open. On test it was found that for switch energy lying between 500 kw. and 800 kw. the duration of the arc was decreased by 20 to 45 per cent. when the oil jets were in operation; below this energy little advantage was gained, and this is probably due to delay in the formation of the jet in full strength. A contact Fig. 4 was constructed, in which the opening of the switch caused a vacuum in the chamber A, so as to induce a strong inrush of oil, as shown by the arrows. This current of oil was found to be effective, and to halve the duration of the arc between 200 kw. and 650 kw. of switch energy; above this value no appreciable improvement was attained, and this failure is attributed to the limited volume of the chamber A. The principle of the device described by Stern and Biermanns† is similar to that of the one just described, the oil inside the chamber being forced outwards by the gases generated. The velocity of the oil stream is greater than in the switch illustrated in Fig. 4, and the arc had the extremely short duration of 0·01 second at 150,000 k.v.a. Methods of this nature are thus shown to be very effective in shortening the arcing period.

It has long been known that the formation of an arc is impeded by increase of pressure in the surrounding atmosphere, and it was thought that this effect might be of use in improving the operation of oil switches. In order to investigate this the large oil switch was tested on non-inductive loads up to 1,000 kw. at 8,000 volts, with various static pressures in the oil container. The result was unexpected. It appeared that the duration of the arc is shortened for small increases of pressure, but that after reaching a minimum value great increases in the duration are observed. These effects are illustrated in Fig. 5. The use of increased pressures is therefore highly dangerous, and is prejudicial to the operation of the switches.

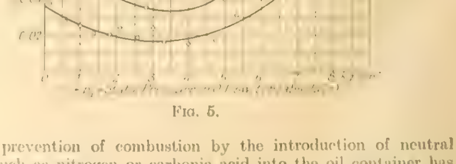


FIG. 5.

The prevention of combustion by the introduction of neutral gases such as nitrogen or carbonic acid into the oil container has often been proposed, but it involves complications that are undesirable. An improvement on this idea consists in mixing with the oil [illegible] that evolve incombustible gases when the switch operates. Oils of this nature have recently appeared on the market under the name of "incombustible oils." They consist of mineral oils to [illegible] are added in solution. These chlorides [illegible] and reduce the viscosity of the mixture, and as they [illegible] temperature (carbonic chloride boils at 78° C.) they [illegible] in the container, and replace the vapour of the [illegible] oil. An oil of this kind, called "Secunol," has proved suc[illegible]. Tests were carried out which showed that no [illegible]

* [illegible] THE ELECTRICIAN, March 3, 1916, p. 771.
† THE ELECTRICIAN, September 7, 1917 (loc. cit.).

combustion was able to be started even with switching accompanied with a strong chimney effect or by attempts to ignite the gas mixture by electric sparking. The separation of carbon particles is greatly increased in this oil, and the cloud of carbon particles that is emitted gives trouble by forming deposits on the parts of the switch, also the gases given off attack metal parts of the switch. An analysis of the gases produced from "Securol" shows that they are composed of two-thirds volume of hydrochloric acid and one third volume of other gases. The hydrochloric acid has practically replaced the hydrogen that is found in the gases formed from ordinary oil. In weighing the advantages and disadvantages of this oil it must be noted that its dielectric strength soon falls to about half that of ordinary oil, although it may have had an equal dielectric strength before it was used. In one set of tests the puncture voltage between needles, with a gap of 5 mm. under the oil, fell from 23,700 volts to 8,700 volts after 10 operations of the switch. This phenomenon is probably due to the formation of hydrochloric acid in solution. On this account switches in which this variety of oil is to be used should have larger dimensions than suffice in the case of switches containing ordinary oil.

The cooling of the gases by passing them through perforated metal sheets is a good way to reduce their liability to burn. Tests made to investigate the action of such sheets showed that several layers are required, and that the sheets must be situated under the surface of the oil, as otherwise combustion commences between the first sheets that are encountered by the gas. The sheets must be carefully insulated or the arc forms upon them. The repeated operation of the switch tends to burn holes in the sheets, and they then fail to perform their function.

The provision of "safety chambers" of such a volume that the mixture produced is not explosive is a device that has been used with success, and in one form of switch this chamber collects the gas from an inverted bell, and in its passage to the chamber the gas passes through a series of perforated metal sheets. The chamber is open to the atmosphere, so that high pressures cannot be produced even in the event of an explosion.

A National Proving House and Standardising Laboratory.*

By Sir RICHARD T. GLAZEBROOK, C.B., F.R.S.

The need of such an institution or institutions is generally admitted. Let me commence with one or two general principles which seem to me essential to success:—

1. Standardisation and testing must be closely connected with research.

2. While there must be close union between the testing authority and the trade concerned with the production of the goods to be certified, the authority should not be dependent on the trade for financial support, and the executive of the testing institution should be an independent authority.

Testing must go hand in hand with research. The latter is necessary in order to set up the standards required. Take, for example, our standards of length. The yard or the metre is the distance between two marks on certain standard bars very carefully preserved. It is clearly of the greatest importance that they should be invariable. Materials alter their dimensions with changing temperatures, and possibly also with time; for standard work this point requires study.

But, I may be asked, for practical purposes do these minutes matter? [illegible] 62 deg., like the inch rule, its length will be greater than when standard. [illegible] 10,000. This, of course, is very small; but in certain 2 in. gauges used in thousands throughout the country the tolerance originally [illegible]

At the laboratory during the past two years we have tested vast [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

A certificate has but little value, even if it states the truth and nothing but the truth, unless it comes from an absolutely impartial source. It is also for the good of the manufacturer. False praise is dangerous to the recipient. The man who relies on the verdict of a too friendly critic may easily fail to maintain the high quality of his products.

A testing laboratory controlled by an association of manufacturers for the advancement of their trade is of much less value, both to them and to the country, than one in which the ultimate decisions rest with an independent authority. Of course, standards must be determined in closest co-operation with the trade. No specification is ever adopted by the Engineering Standards Committee until it has been fully discussed at meetings at which the trade is fully represented. At the Laboratory we have advisory Committees on various matters. Executive powers rest with the Executive Committee, or with the director acting under the instructions of that Committee. He signs all the certificates, and is responsible only to the Committee.

Turning now to the actual test work, a few instances may be briefly mentioned. [illegible]

Meteorological and clinical thermometers were tested at Kew many years before the Laboratory was founded; the number of instruments now dealt with has greatly increased, and while the apparatus has been improved and modernised, the principles remain [illegible] for testing. Before the war they were sent in considerable numbers, and the makers had become so efficient that the rejections averaged [illegible] demand. Skilled workmen were scarce. The failures ran up to 18, [illegible] of Munitions, and makers were told that all their goods must pass the [illegible]

As other illustrations may be mentioned the optical tests. All [illegible] laboratory. There is also much work on the determination of [illegible]

[illegible]

[illegible]

* [illegible]

There is already a standard inch and an "Enfield" inch; we do not want Manchester, Leeds, and Birmingham inches. Similarly such anomalies as the great variety of gauges for wire and thin sheets of metal are undesirable.

The National Physical Laboratory has come under new control so far as its finance is concerned. Steps have been taken to increase considerably the facilities at the laboratory for many of the tests required.

A scheme has been developed for the standardisation and issue of certificates relating to chemical glassware.

The quantity of the various articles dealt with is very large, and it is not necessary that all should be tested in the same limits of accuracy, nor would it be possible to send them all to the laboratory. This difficulty will be met by having two classes of goods treated differently. For work of the highest accuracy the articles should be sent to Teddington and tested individually. Those that pass the test will constitute Class A, and will receive the laboratory mark. The vast majority will be dealt with at local centres organised by the laboratory and manned by members of the laboratory staff. These centres may be at the large works, or at the local universities or technical colleges. At the head of each will be the National Physical Laboratory inspector, who will be free to visit the works, inspect the methods of manufacture, and select samples for test. So long as the methods remain satisfactory and the goods come up to standard the firm will be licensed to mark the articles in some distinctive way.

A fee will be charged for each article tested at the laboratory. In the case of the articles inspected or tested in bulk, it is proposed to cover expense by a royalty reckoned on the numbers produced which would be charged for permission to use the trade mark.

Such a scheme requires the cordial co-operation of the makers and the inspecting authority, and this we have already been promised. Such a plan is far preferable to the alternative under which an association of the manufacturers would run their own testing laboratory.

A similar scheme is applicable to other industries. For engineering work the standards of the Engineering Standards Committee are mostly adopted. The laboratory holds the standard screw gauges of the Committee as well as the rail templates and other similar standards.

Or again, with electrical instruments, supply meters, ammeters, voltmeters and the like can be, and are, sent to the laboratory and where high accuracy is required this must be done.

The Engineering Standards Committee have specified the performance tests for motors and dynamos requisite before the term "British Standard" can be applied to them. It is impossible to expect every small motor to be put through these tests. But a limited number of the type might be tested out at the National Physical Laboratory, and steps taken by inspection and occasional tests to secure that in subsequent production the same standard is attained; and so long as this is done to license the manufacturer to put the Engineering Standards Committee's mark on his machine and call it a British standard machine.

The process can be extended to other electrical products; it has already been suggested for lamps. Now is the time to develop a scheme of the kind so that we may be ready when once more peace reigns on earth among men of good-will.

(To be concluded.)

Notes on the Design of Electromagnetic Machines.*

PART III.

DESIGN OF AN ALTERNATING-CURRENT TURBO-GENERATOR.

By STANLEY PARKER SMITH, D.Sc.

(Concluded from page 746.)

Summary.—In Part I. of the article the author deals with some of the main principles underlying the design of alternating-current generators. In Part II. these principles are applied to the design of a low-speed, three-phase alternator, giving 750 kw. at 2,200 volts when running at a speed of 250 revs. per min. In Part III. a three-phase turbo-alternator is designed to give 2,000 kw. at 3,000 revs. per min. at a line pressure of 500 volts, and the mechanical stresses in the rotor are discussed.

(e) *Calculation of the Critical Speed.*—It is now necessary to design the shaft beyond the ends of the rotor core. There is little deflection in the core itself, whilst in the shaft beyond the core there is little weight, consequently the deflection (and hence the critical speed) is determined substantially by the weight of the core and the stiffness of the shaft. Care must be taken to avoid any sudden change in the diameter of the shaft.

The diameter of the journal lies between two limits; the upper limit is the maximum permissible rubbing speed in the bearings, while the lower limit is the maximum combined bending and torsional stress in the neck of the journal. With [illegible] it is permissible to employ a peripheral speed in the bearings of [illegible] ft. per minute (25 metres per second), whilst the combined torsional and bending stress [illegible]. The portion of the shaft [illegible] the end bells, the air-cowls and the slip-rings, as seen from Fig. 18.

[illegible]

[illegible]

[illegible]

* [illegible]

into a detailed discussion of the critical speed of shafts.* Accordingly only a brief reference will be given here to the method commonly employed by electrical engineers in this country for calculating the critical speed of turbo-rotors, prefixing merely a simple explanation of the grounds on which it is based.

For shafts of the kind used in turbo-alternators, it is generally agreed that the critical speed is the speed corresponding to the natural frequency of transverse vibration of the shaft. Thus, by calculating the latter the former is determined. The natural frequency of a horizontal shaft can be calculated when the deflection due to its own weight is known. If an element W is deflected a distance y due to its own weight, then, when the shaft is swinging freely, the maximum value of the kinetic energy $\frac{1}{2}\frac{W}{g}\omega^2 y^2$ is equal to the maximum value of the potential energy $\frac{1}{2}Wy$, so that for a shaft consisting of a number of loads, W_1, W_2, W_3, &c., we have

$$\frac{\omega^2}{g}(W_1y_1^2 + W_2y_2^2 + \ldots) = W_1y_1 + W_2y_2 + \ldots$$

Thus the natural frequency of the shaft $f = \omega/2\pi$ is found.

For the critical speed we have only to replace the period of vibration by the period of rotation, so that the critical speed,

$$= \frac{60\,\omega}{2\pi} = \frac{30}{\pi}\sqrt{\frac{g\,\Sigma Wy}{\Sigma Wy^2}} \text{ revolutions per minute.}$$

* For further information on critical speed, the reader should consult [illegible] Stodola, "The Steam Turbine"; Dunkerley, "Phil. Trans.," [illegible] Vol. 185; Chree, "Philosophical Magazine," Vol. VII, [illegible] Morley, "Engineering," Vol. 88.

Treated in this way, then, the determination of the critical speed resolves itself into the calculation of the static deflection of the shaft caused by its own weight. As this is a common exercise in mechanics, it is only proposed to draw attention here to points calling for special comment in connection with the present problem.

The cross-section of the rotor core is generally an irregular figure due to the slots, holes, ducts, &c., needed for the winding and ventilation of the rotor. At the outset, therefore, we must find the diameter of the equivalent solid shaft. This is calculated from the least moment of inertia (about a diameter) of the actual cross-section, which can be determined graphically, or better still, by means of a moment integrator. In the present case the diameter of the equivalent solid shaft is found to be 53·4 cm. A longitudinal section of the shaft, or half-section for a symmetrical case, is then laid out, as shown in Fig. 28, and the loads at the various points calculated. By integrating the load diagram we get the shear stress diagram (not shown) whilst a second integration gives the bending moment diagram.

Since the deflection depends on the moment of inertia I, and $I/I'=D^4/D'^4$, we must now reduce the bending moment diagram for the shaft of varying diameter to a bending moment diagram for a shaft of constant diameter. This is done by multiplying the ordinates of the bending moment diagram where the section of the shaft changes by D'^4/D^4, where D' has been chosen equal to 53 cm. By integrating the reduced bending moment diagram the slope is obtained, and integrating this again gives the deflection diagram.

Care must be taken to keep the scales clear throughout. Thus in the original drawing of Fig. 28 we had:

a = linear scale, 1 cm. = 5 cm.;
b = load scale in first polar diagram, 1 cm. = 100 kg.;
c = load scale in second polar diagram, 1 cm. = 10 cm²;
d = polar distance in first polar diagram, 20 cm.;
e = polar distance in second polar diagram, 20 cm.;

then 1 cm. of any ordinate in the original of Fig. 28 represents

$$\frac{a^3bcde}{EI'} = \frac{5^3 \times 100 \times 10 \times 20 \times 20}{2{\cdot}04 \times 10^6 \times 53^4 \pi/64} = 0{\cdot}00213 \text{ cm.},$$

where E=Young's modulus of elasticity$=2{\cdot}04\times10^6$ kg. per cm², and $I'=\pi D'^4/64$=moment of inertia of equivalent shaft of constant diameter D'.

Thus the actual deflection y is obtained by multiplying the measured deflection y' by 0·00213.

We can now draw up the following table:—

y'	y	y^2	W	Wy	Wy^2
2·60	0·00554	[illegible]	56·5	0·313	0·00173
5·95	0·01267	[illegible]	62·0	0·785	0·00992
7·00	0·01491	0·000222	31·0	0·462	0·00688
7·60	0·01619	0·000262	220·0	3·560	0·05763
8·10	0·01726	0·000298	181·0	3·122	0·05396
8·12	0·01729	0·000299	214·5	3·708	0·06409
8·14	0·01734	0·000300	214·5	3·720	0·06435
8·16	0·01738	0·000302	214·5	3·728	0·06475
8·18	0·01742	0·000303	214·5	3·734	0·06498
8·20	0·01747	0·000305	214·5	3·745	0·06540

Then $\Sigma Wy=26{\cdot}877$ and $\Sigma Wy^2=0{\cdot}45365$, so that the critical speed

$$n = \frac{30}{\pi}\sqrt{981\frac{26{\cdot}877}{0{\cdot}45365}} = 2{,}300 \text{ revolutions per minute.}$$

As this is only 77 per cent. of the normal speed, the margin is quite ample. Actual experience shows that the above approximate method is reliable to within about 10 per cent.

The method of calculating the critical speed from the deflection of the shaft was given by Morley, and the method referred to above and is the one most usually applied to turbo-rotors, but it has been found that the methods given by Stodola, Dunkerley and Chree also give a very close result when correctly applied. All the methods are necessarily approximate, for the reason that assumptions have to be made, the correctness of which cannot be demonstrated, though the results are usually as satisfactory as are necessary for practical purposes.

The above calculation of the critical speed assumes a shaft supported by two bearings, and the question arises as to what the effect will be of the coupling connecting the turbine to the generator when this coupling is rigid, as is often the case at the present day. In reply, it may be stated that [illegible] the practice of many turbine builders to take the [illegible]

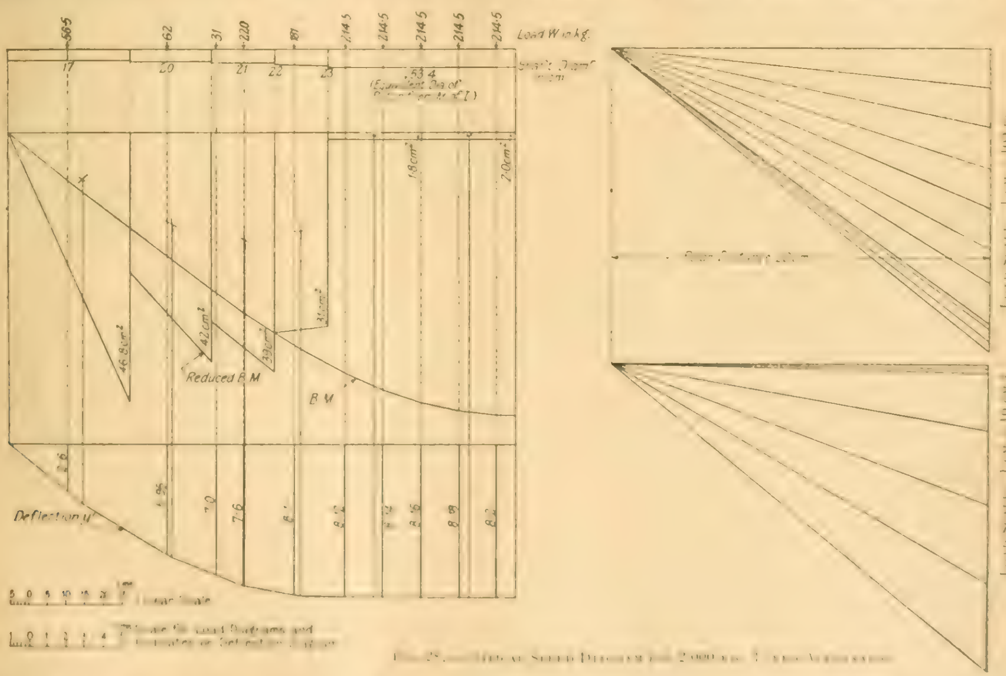


FIG. 28.—CRITICAL SPEED DIAGRAM FOR 2,000 KW. TURBO-ALTERNATOR.

ing so that the two coupling flanges are parallel before they are bolted together, and under these conditions it is found that rigid couplings have no appreciable effect on the critical speed. The author would like to take this opportunity of expressing his indebtedness to Dr. S. F. Barclay, of Messrs. Vickers (Ltd.), for much valuable information on the theory underlying the construction of high-speed machinery.

This article was written at the City and Guilds (Engineering) College, and will be reprinted as an Electrician Monograph.

SCHEDULE OF LEADING PARTICULARS OF DESIGN.

Alternating-current Turbo-generator.

Number of phases	Three
Output	2,000 kw. at cos φ = 0·8
Line pressure	500 volts, with phases joined in star
Phase current	2,900 amperes
Speed	3,000 revs. per min.
Frequency	50 cycles per second.
Temperature rises to be in accordance with E.S.C. rules.	

Main Dimensions.

Number of poles, $2p$	2
Outside diameter of stator core	150 cm.
Inside diameter of stator core, D	65 cm.
Periphery at stator bore, πD	204 cm.
Pole-pitch at stator bore, Y	102 cm.
Air-gap, l_g	2 cm.
Rotor diameter, D_R	61 cm.
Pole-pitch at rotor periphery, Y_R	96 cm.
Peripheral speed, v	96 m. per sec.
Total core-length, L	100 cm.
Number of radial ducts	0
Thickness of stator laminations (29 S.W.G.)	0·35 mm.
Iron length of stator core	87 cm.
Iron length of rotor (solid forging)	100 cm.
Output coefficient, C	11·8

Stator Slots and Ducts.

Number of slots, S	36
Slot-pitch, τ	5·67 cm.
Size of slot	52 × 22 mm., with 8 mm. opening.
Axial ventilating ducts:	
36 rectangular holes	25 × 22 mm., below slots.
144 round holes	4·5 cm. diameter, in 4 circles.

Rotor Slots and Ducts.

Number of slot-pitches	26
Slot-pitch	7·36 cm.
Number of wound slots	16
Size of wound slot	28 mm. wide × 105 mm. deep, including 15 mm. phosphor bronze wedge.
Axial ventilating ducts:	
12 tapered ducts	35 mm. deep, below wound slots.
4 tapered ducts	25 mm. deep, below wound slots near pole centre.
10 empty slots in pole-centres	28 mm. wide and 75 mm. deep, including 10 mm. steel wedge

Stator Winding.

Type of winding	Six-phase, single-layer winding, with opposite phases joined in parallel to form three-phase winding.
Number of parallel circuits per phase	2
Current per circuit, I_a	1,450 amperes
Number of slots per pole and phase, q	6
Number of coil-sides per slot, u	1
Number of turns per coil, T_c	1
Number of turns per phase in series, T	3
Conductor, section, A	462 mm²
Conductor made of compressed strand	2(17 × 17) mm., wound one above the other, crossed in overhang.
Overhang copper	8 strips per conductor, each 16 × 2·5 mm.
Resistance per phase, R	0·00043 ohm at 15°C.
Effective reactance drop at full load	14·0 per cent.

Rotor Winding.

Type of winding	4 coils per pole, wound in slots.
Number of conductors per slot	32 wound one above the other.
Number of turns per pole-pair	256
Conductor, section, a	55 mm².
Conductor, made of strip	25 × 2·2 mm.
Insulation between turns	0·25 mm. mica.
Resistance of exciting winding	0·29 ohm at 15°C.

Specific Loading.

Specific electric loading, ac	256
Specific magnetic loading, B_{mean}	4,460

The Control of Large Amounts of Power.

The following discussion took place on Mr. E. R. Wedmore's Paper on this subject (abstracted in our last issue) at the meeting of the Institution of Electrical Engineers on Thursday, March 7.

Mr. C. P. Sparks said the author drew attention to the possibility [illegible] comparatively large cables at very high pressure. [illegible] burning off. A point was reached where [illegible] of a small size could not be put in. With regard to the author's proposal to divide a large system into sections in parallel through reactances, he thought it a mistake to have reactances [illegible] feeder. The use of reactance on the bigger [illegible] difficult because the machine and trans- [illegible] but without the automatic regulator it would [illegible] satisfactorily. He agreed that [illegible]. It was interesting to hear that from [illegible] point of view there were no insuperable difficulties in the [illegible] cables and switchgear to deal with [illegible] would have yet to be reckoned with.

Mr. H. [illegible] said, in reference to the author's remark about a [illegible] 100,000 amperes on 6,000 volts raising the temperature of a [illegible] at the initial rate of 12,000°C. per second, he doubted [illegible] 6,000 volts one could get 100,000 amperes in a [illegible]. He [illegible] between two fixed points [illegible] 1,000 amperes [illegible]. A current of 100,000 amperes on the [illegible] practically [illegible]. [illegible] current would [illegible] perhaps [illegible] current due mainly to the [illegible]. [illegible] from the [illegible] and [illegible] He [illegible] Deptford [illegible]

[illegible]

and he jointly had under consideration some three or four years ago, Mr. Wedmore himself recommended 30 per cent. reactance between adjacent sections in order that, on the occasion of a "short" on the middle section of a line of, say, three busbars, the current paid into this bar through each reactance (*i.e.*, at each end of the bar) should not exceed 25 per cent. of the short circuit current of the central section. This was for a ring system, and for a star system it would be 15 per cent. reactance. The Paper stated that, with 15 per cent. reactance in the 'bus, only 0·15 of the load of the 'bus could be transferred from adjacent sections if the voltage rise was not to exceed 1 per cent., so that on a 20,000 kw. section only 3,000 k.v.a. could be transferred under working conditions, which was not enough. If the voltage were 10,000, even this would mean 100 volts difference of potential between the 'bus bars. But to transfer half the load would require something like 3½ to 4 per cent. of potential rise; or, say, 400 volts between 'bus bars. The sub-stations fed from different sections of the main busbars would, therefore, be at from 400 to 1,000 volts difference of potential among themselves and interconnectors would be impracticable. Suppose there were three 'bus sections, each with its own generators, and that the central section, owing to irregular distribution of the load, was greatly overloaded. The two outside generators were arranged to supply current through the reactances to the central section at unity P.F. If now, the actual load had a power factor of 0·8 P.F., there would still be a 60 per cent. lagging component to be supplied by the central machine, and if the P.F. of the load were 0·6 it would be worse. The central generator was fed with magnetising current and might easily be down to 0·6 P.F. This meant that its angular position was some 60 deg. different from that of the two others, and if a short occurred there might be considerable phase-swinging, with risk of it falling out of step. Mr. Wedmore showed sections of the 'bus bar directly joined together by short circuiting the reactances; but he forgot to state that, if any adjacent pair of 'bus sections be connected by trunks to an adjacent pair of 'bus sections in a large station fed from the big station, but having its own generating plant, the operation would result in considerable disturbance and risk of burning out switchgear at the secondary station if a short occurred there at the time, because there would be too many kilowatts on an undivided section of the bars at the smaller station. The author said the advantages of employing reactances in the generator were were that it was cheaper, and it did not hinder

voltage control under normal conditions. His recollection was that the machine with the external reactance came out the cheaper (including the reactance); and the builders stated that, with bigger machines, the advantage would be increased. From the user's point of view he still maintained the greater security of the external reactance which could, in addition, be incorporated in the main 'bus reactance chamber and serve to protect main cables (to the generator) and even the generator oil switch itself. With regard to voltage control, he knew of no voltage control difficulties that did not apply equally to the two cases. He agreed with Mr. Wedmore's notes about the forces obtaining between conductors. He had seen a switch which failed to open (through the current transformer failing), on a short circuit just beyond the 'bus bars, on which the three movable blades were all broken off by the repulsive forces of the currents (there being no arc). The great value of the reactance, as against any known form of switch, was that it operated in time to prevent the first half wave of current from being generated. With the advent of the reactance he felt that the question was largely solved, provided that the reactance could be relied on permanently, and he believed the B.T.H. reactances which were being put in in Birmingham would fulfil that condition.

Mr. E. P. HOLLIS said a small consumer could not spend much on his installation, and if his transformer or switch failed then his system, though small, was ready to pour its 20,000 amperes into the fault. He was not sure they were going in the right direction. The restricted value of the short circuit current in 50,000 or 70,000 k.v.a. sets was greater than the unrestricted short circuit currents of a 5,000 kw. set, but they were doing the same thing for both. More reactance could not be put in because of regulation and other matters. He thought there must be some way of introducing a protective device which would limit the flow of short circuit current but would not affect normal currents. It was barbarous to break the full force of short circuit current on switchgear.

Mr. A. H. ELLIS said several years ago reactance was considered anathema in electric supply, but now one was told to install it almost *ad lib.* In large cable systems the capacity effect was greatest. If inductances were added in the shape of reactance coils, where was this to stop? The author gave the amount of reactance and where to connect it to give the greatest protection, but said nothing about the frequency of the supply. If the figures given were based on 25 ~ then for 50 ~ the inherent impedance of the cables would be twice as much, and much less artificial reactance would be required. The author referred to the difficulty of designing large switchgear, &c., for meeting the increased strain. Then why add reactances? There was a limit to putting reactances in the generators both on account of the cost and because a machine, such as a large turbo generator, lost its volts on a severe short circuit. Any control of the voltage was almost entirely ruled out for the same reason. He thought other methods of obtaining the desired effect ought to be considered. The author proposed to step up the pressure for the three mile distribution scheme. This only seemed to add another weak point in the chain.

Mr. A. J. COLLIS asked the author to explain how he obtained the figures given in his curve on the instantaneous rise of short circuit current with or without reactance, as they did not appear to agree with tests previously obtained. [illegible] was limited by its armature impedance, and it was generally calculated [illegible] ferable to have the generators wound for this pressure rather than to [illegible]

[illegible]

[illegible]

generators? With large power stations the diversity factor was so high that hand control was possible, even with poorly regulated generators. For connecting sections outside with large systems he favoured small feeders with 4 or 5 per cent. reactance. If the feeder must be large, regulators should be used at the far end. He made the tests on the switch Mr. Highfield spoke of in Germany in 1901, and it worked well.

Mr. BRAZIL said he had fuses on 4,000 k.v.a. feeder circuits and they broke the circuit without disturbing the oil in which they were immersed. He preferred fuses to automatics because they were not likely to be hung up by mechanical defects.

Mr. A. R. EVEREST said he agreed with the author's recommendations as to precautions for keeping up the factor of safety that would become greater with the large units. Did they all mean the same thing by a "reactance." A 10 per cent. reactance must mean a machine that would allow 10 times the full load current to flow if short circuited. The reactance referred to in these discussions on short circuits must be the reactance after taking into account any saturation which occurred.

Mr. SANDIFORD thought reactances should be standardised, which could be done very quickly. In a current limiting reactance described by the author, concrete was used. He thought that might absorb damp, and that porcelain would be a better material. The copper conductor shown was bare, and might attract dust.

The AUTHOR, replying to the discussion, said Capt. Taylor had dealt with recommendations he (Mr. Wedmore) made five years ago and not with figures in the Paper. The 30 per cent. was the carrying capacity, but the actual capacity was 20 per cent. That was passed on machines with higher reactance than he now recommended. His figures were worked out on 50 cycles. Where feeder reactance was less the necessity for artificial reactance was greater. In reference to Mr. Collis's remarks, no one would suggest that a machine giving 40 times normal load current on the first rush was a model machine. There were many hundreds of the oil switches he described in use in this country. Satisfactory fuses had been developed for dealing economically with small circuits. In reply to Mr. Sandiford, it was convenient to see inside the reactance without having to take it to pieces. The mechanical character of porcelain was poor, and he preferred to use concrete where possible.

Mr. WEDMORE said he had communications from Mr. Phillip Torchio, of the New York Edison Co. and Mr. R. F. Schuchardt, of the Commonwealth Edison Co., of which the following are extracts:—

Mr. Torchio wrote that the Detroit Edison plant had a 45,000 kw. unit and he understood some 50,000 kw. units were on order. The internal reactance of the largest generators on order was 16 per cent., and in addition to this it was intended to insral external reactors of approximately 6 per cent. He saw no objection to having a combined external and internal reactance of the generator as high as 20 per cent. to 25 per cent. With the installation of 'bus reactance, the total amount of reactance (including 'bus and generator) should be below 50 per cent., especially on conditions where there was a very fluctuating load. In extra high voltage lines it was more satisfactory to perform the switch operation on the low-tension sides of the transformer, to avoid high frequency surges. The greatest amount of protection could be obtained by the use of feeder reactors. With feeder reactors of about 3 per cent., the short circuit current was well within the rupturing capacity of modern switches. He would not recommend, except under special conditions, a 'bus reactance greater than 40 per cent. based on the full load current of the bus section. Where stations were tied together through feeders offering [illegible] His Company had not experienced any difficulty with parallel operation in cases where the reactance was at least 1·73 times the resistance. The installation of feeder reactance coils increased the stability of the rotary converters.

Mr. Schuchardt expressed the opinion that reactance was desirable [illegible] ferable to have the generators wound for this pressure rather than to [illegible] faults.

Books Received.

[illegible]

The Electrician.

FRIDAY, MARCH 15th, 1918.

Editorial and Publishing Offices:—

8, BOUVERIE STREET, LONDON, E.C. 4.

Telephone: City 9853 (4 lines). Telegrams: "Benbrotric Fleet London."

Fuel Resources.

Of the many subjects which are occupying the minds of engineers at the present time that of the more efficient use of our fuel resources occupies a prominent position. Among recent Papers on the subject, reference may be made to one by Prof. W. H. Watkinson, read last month before the Liverpool Engineering Society. The author deals with a certain number of points to which we need not refer in detail, such as the inefficient use of coal in coke ovens and the use of fuel in the iron and steel industry generally. When he comes to domestic heating we reach a field in which electricity supply has a greater interest. There can be little doubt that, as time goes on, the waste of fuel, which is only too evident in private houses, will become reduced, and that electricity, notwithstanding its thermodynamic limitations in generation by steam plant, will play a considerable part in this direction. The coal fire undoubtedly has an element of comfort, but from the point of view of elimination of waste and the provision of a more healthy atmosphere there can be no question that its use must be distinctly limited in the near future.

When we come to power, we have the theoretically highly efficient gas and oil engines on the one hand, and the less efficient steam turbine on the other. In the case of small powers there is no question that the gas engine and the oil engine are at a very distinct advantage. Steam plant, on the other hand, in such cases usually cuts but a poor figure, largely due to the fact that such plant is generally in unskilled hands. Even where skilled labour is employed, small steam plant could not seriously compete with electric power from an up-to-date power plant. When we come to powers such as 500 kw. and 1,000 kw. it is more difficult to say just what is the best plant to use. It is only when larger powers are involved that the high capital cost and high maintenance of gas-engine plant altogether obscures the higher thermo-dynamic efficiency that may be obtained, and that the steam turbine shows to increasing advantage.

It is becoming more and more evident that the really large power station may become bound up very intimately with the complete gasification of fuel. Here we come to the possibility of transmission of gas as opposed to carriage of coal. Prof. Watkinson is of the opinion that coking or gasification of the fuel should be carried out entirely at the collieries, and that the resulting gas should be piped to the power stations, which could be placed where there are proper facilities for condensing water. Calculations show that gas can be piped over a distance of 100 miles with a loss of less than 10 per cent. of the energy transmitted. In Staffordshire there is the well-known Mond system which distributes power gas over an area of 123 sq. miles at a cost of [illegible] per 1,000 cub. ft. The cost of distributing a volume of this gas having a calorific value equal to that of a ton of coal is [illegible], and the statement is made that the cost of distributing a ton of coal by the truck and cart method to any point within the area of 123 sq. miles would on the average greatly exceed this figure. It is pointed out also that in America natural gas is piped to a distance of 300 miles and in one case the pipe line pressure is 1,100 lb. per square inch. Undoubtedly the relative merits of the two methods of transmission require careful consideration. It appears to us, however, that there might be some difficulty in coupling up a number of collieries to give the necessary gas supply. Moreover, the handling of coal would have to be on a very different scale from that which is frequently adopted in this country. We do not doubt that if such methods as we described in The Electrician recently were adopted the cost of transport and handling per ton of coal would be very much lower than the figure which is generally attained.

With regard to gasification we must, of course, draw a distinction between low-temperature gasification and total gasification. In low-temperature carbonisation much remains to be proved on a commercial scale. Recently articles have appeared in the "Financier" giving many results that may be obtained, and the impression is given that the results mentioned are actually being obtained, by the Coalite plant at Barnsley. If this is so, we think it should be more definitely stated, together with the scale of working. If it is not the case, and we confess to doubts on the subject, it should be equally distinctly stated that the results are those which it is hoped to obtain. Low-temperature carbonisation is too important a subject for results to be stated in any ambiguous fashion.

Reviews.

Manual of Reinforced Concrete. By C. F. Marsh and W. Dunn (London: Constable & Co.) Pp. xvi.+475. 10s. 6d. net.

In view of the important part played by reinforced concrete in the several branches of engineering, it behoves all engineers to have at least some working knowledge of the subject. The fact that the book under notice is now in its third edition is evidence that it has been acceptable to engineers.

The book has been re-written and considerably enlarged, and many new tables and diagrams have been added. This new matter results in a book of about 500 pages as against the 290 pages of the first edition, and in addition to 191 diagrams there are 79 tables.

Of the six parts into which the book is divided, the first deals with Materials, and into 45 pages the authors succeed in compressing a large amount of modern information. Due prominence is given to standard specifications, and reference is made to investigations carried out in America by the Bureau of Standards. These investigations, which dealt with the effect of electric currents on concrete, are authoritative and are sufficiently important to warrant a useful study by those responsible for the safety of structures in which steel is embedded in concrete. We are of the opinion that a list of references to researches on corrosion would be useful to many readers.

Construction is considered in the second part. Further space could with advantage be given to the section on the design of reinforced concrete structures as influenced by the cost of the framework, and comparative costs of alternative schemes would be helpful. The matter in the section on the construction and driving of piles is well found, and this applies equally to several of the other sections in this part of the work.

The third part is devoted to waterproofing, fire resistance, electrolysis, expansion and contraction, and effects of sewage. The summarised conclusions of many of the authorities on these several subjects will be welcome to the busy engineer. It was mentioned above that the authors refer to investigations carried out in the United States. The extended reference to these in this part of the book should prove useful to those not having easy access to an up-to-date technological library.

Loads, bending moments and shearing forces are dealt with in the fourth part, and we notice many useful and original tables. Calculations follow in the fifth part, and it is here that many electrical engineers will be disappointed. Not that

examples are wanting, but in view of the rapidly extending use of reinforced concrete in the construction of foundations for heavy machinery, of coal bunkers and the like, we think it would be advisable to deal with these at some length in the next edition. An interesting and economical type of bunker is one having a parabolic section, and notes on this would be helpful.

General information is given in the sixth part, and the many tables and diagrams are likely to be of great assistance to those who may have occasion to use them. A very full index brings the work to a close.

By many the war is made an excuse for using cheap paper and for shoddy printing. This book is well printed on good paper, and the large type used makes reading a pleasure.

H. H. B.

Practical Dynamo and Motor Management. London: S. Rentell & Co. Ltd. Pp. 52. [illegible]

The anonymous author of this little book tells us in the preface that the information contained in it is intended for the machine attendant. It appears, however, that any man who holds such a position should already know how to remedy the troubles dealt with, before he is entrusted with the care of machines. On looking through the pages we find one piece of advice which is rather misleading, and another decidedly dangerous. The former is in connection with the neutral position of the brushes. The reader is advised to set the brush on the commutator segment connected to the armature coil in the slot midway between two pole-tips. It is usually very difficult to find this within a segment or two owing to the banding. The latter is in testing for unevenness of the commutator, the unfortunate attendant being recommended to put his finger on the commutator without being warned of the necessary precautions. It is not stated that the diagrams of connections at the end of the book only apply to one method of winding the armature, and are not universal.

R. G. J.

Notes on the Audion.*

By L. W. AUSTIN.

(U.S. Naval Radiotelegraphic Laboratory.)

A number of observations on the De Forest [illegible] audion have been made at the U.S. Naval Radiotelegraphic Laboratory.

[illegible]

[illegible]

* [illegible]

0·92 volt at 60 cycles was used. In the neighbourhood of zero direct current grid voltage the usual decrease of plate current and increase of grid current are noted, while with changing grid voltage the signals change both in magnitude and sign due apparently to changes in curvature of the two characteristics.

The same curves are obtained if undamped radio frequency excitation of the same strength is used in place of the 60 cycles. In this case the grid galvanometer is shunted with a low non-inductive resistance to allow the oscillations to pass freely. Here

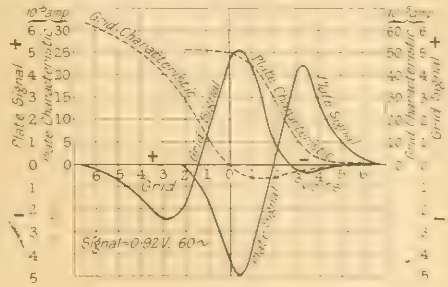


Fig. 1.

the stopping condenser plays little part. If, however, [illegible] is placed in series with the grid galvanometer so as to force the oscillations through the stopping condenser, the appearance of the curves is much changed. The grid signal is positive and nearly uniform over a wide range of grid direct current voltage, while the plate signal is similarly negative except for strongly negative grid, where both signals reverse slightly. Apparently here some other effects appear in addition to those due to the changes in grid and plate characteristics.

Discussion by the Faraday Society on Electric Furnaces.

The chairman, Prof. C. A. Edwards, D.Sc., in introducing the subject, gave a short account of the history of electric smelting since Siemens in 1878 patented his first small coke electric furnace. In 1904 there were only four electric furnaces in Europe and America, in 1913 there were 114. Development since the war had been phenomenal.

Mr. H. Etchells read a Paper on "Applications of Electric Furnace Methods to Industrial Processes." The author referred to the growth of electric furnace industries during the war. Electric furnaces might be of the induction, resistance and arc types, but only the latter two types were likely to find extensive development. The resistance furnace was ideal from the electric load viewpoint, giving high load factor, high power factor and very slight fluctuation. Only the Bailey furnaces had hitherto attained an industrial development [illegible]

[illegible]

having four electrodes over a circular bath. Further, at present we only had electrodes which would take currents of, say, 10,000 amperes; where more than 20,000 amperes were required more than two electrodes were needed. In the use of four upper electrodes, it was explained that the system must be such that when equal currents are flowing through each of the arcs then equal currents must be taken from each of the three high-tension mains. Each of these three primary currents must be practically in phase with its voltage in order to secure a higher power factor. Further, for metallurgical reasons it was desirable that some current should flow vertically through the hearth to a fifth fixed electrode beneath it. Therefore the system should impress an equal voltage between each upper electrode and the hearth electrode.

The condition was met by providing on the furnace side of the transformers four equal phases, one for each electrode, and a common return to a neutral electrode beneath the hearth—in short, a four-phase five-wire system. The problem has been satisfactorily solved by the electro-metals four-phase arrangement, which consisted of three single-phase transformers, two of which had their terminals connected separately to the four upper electrodes. This system gave an equal voltage in each of the arcs, and therefore equal heating zones, and a power factor on a non-inductive load of unity.

A Paper on "Electric Furnace Control" was presented by Mr. A. P. M. Fleming and Mr. F. E. Hill, setting forth the general principles on which temperature control is based in the case of furnaces using alternating currents.

The methods of control were based either on voltage or current variation. Voltage control was effected by a variety of methods, such as altering the ratio of the main transformer, the use of primary or secondary boosters, transformers, &c.

Control of current was accomplished by raising or lowering the electrodes, and might be auxiliary to any of the methods previously mentioned. Examples of both hand regulation and automatic regulation were given in the Paper.

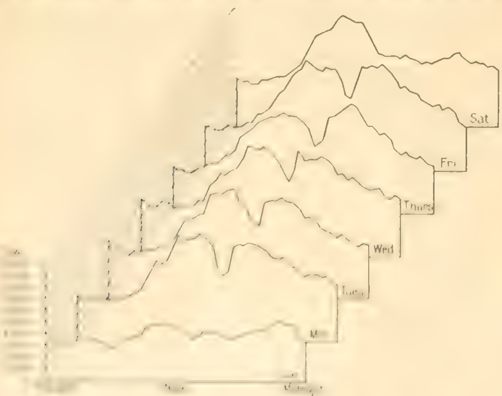
Correspondence.

LOAD RELIEF MAPS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The Load Relief Map described by Mr. Le Roy Robertson is of great value and interest and is a device which has not been used to any considerable extent in this country, so far.

The writer has, however, found it convenient to prepare relief models of this kind covering short periods such as a



[illegible] and would also draw attention to the fact that [illegible] load period a very [illegible] may be obtained by preparing a number of 24 hour curves [illegible] in correct perspective.

The preparation of [illegible] than might be [illegible] and painted with [illegible] and care taken that the [illegible] [illegible] the [illegible] [illegible] days [illegible]

holidays, after which cards can be neatly cut out and boxed up by non-technical labour.

It will be observed that by looking at the block of cards at right angles to the front of the cards, a new and interesting series of profiles arise showing variations in maximum demand at any given hour of the night or day across the year.

It is interesting to note that the weight of the cut out card as a percentage of the weight of the uncut cards gives an approximate value for the load factor, and that if the cards are firmly compressed and fitted into a tightly-fitting box, the interior of which is graduated with kilowatt lines, it is possible to determine the load factor of portions of the load by the simple expedient of filling up the gaps in the box with fine sand, or similar material, to different kilowatt levels, and then taking the weight of the sand so used as a percentage of the weight of sand required to fill the empty box to the topmost peak. This affords a ready means of getting an approximate value of the load factor of upper parts of the yearly load block.

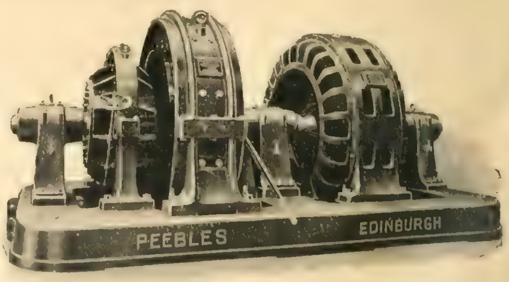
Similarly it will be found very useful at times to build up solid models from 24-hour curves obtained on consumers' premises. These show, in a striking way, the influence and incidence across the 24 hours, and across the year, of special applications of electricity, such as cooking, and the method generally is well worthy of attention and many variations of it will suggest themselves.—I am, &c.,

West Ham, March 4.

J. W. Beauchamp, M.I.E.E.,
Engineer and Manager.

Large Motor Converters.

Messrs. Bruce Peebles & Co. have recently manufactured a 2,000 kw. 50 cycle Peebles Motor Converter for the Sydney Municipal Council, Australia, this making the fourth 50 cycle motor converter unit supplied to the Municipality in question, the other three machines each being of 1,000 kw. capacity. A few years back this firm supplied to the Manchester Corporation a 2,200 kw. 50 cycle motor converter, and since that time, in addition to a 2,000 kw. set, they have received an order for a 2,000 kw. motor converter (not yet manufactured) for Johannesburg Municipality, and within the past few weeks the Manchester Corporation have placed an order with them for a still larger machine, this time of 2,400 kw. capacity. One of these 2,000 kw. converters is shown in the illustration.



2,000 kw. Motor Converter.

In connection with the above mentioned 2,000/2,400 kw. motor converters it is of interest to note that they are the largest 50 cycle converting units which have ever been manufactured in Great Britain. They run at 300 revs. per min. and are arranged with three pedestal bearings, the bed plate is split longitudinally, the facings being carefully machined and bolted together. Barring gear is provided for barring round the rotating element for cleaning or other purposes when the machine is not in operation.

The alternating current supply, which is switched direct on to the stator, is three phase, 50 cycles, 6,000 volts, and the continuous current end, which is shunt wound, gives its output at 485/510 volts. Owing to the heavy continuous current, viz., 4,125 amperes, the direct current end has a double commutator, and the brush gear, which is carried from the bed plate, is of particularly substantial construction.

The machine is designed to deal continuously with an out of balance current equal to [illegible] per cent. of normal full load, i.e., about 1,000 amperes, and with this out of balance current the voltage difference between the two halves will not be more than 1 per cent. of the voltage across the outers.

This particular set, for special reasons, is started up from the direct current end by means of a multiple-lever starter, which is short-circuited with a 4,000 ampere heavy laminated short-circuiting switch after the machine has been run up to speed. When it is installed in Sydney the starter will be mounted on the bedplate between the alternating current and direct current machines, giving a very compact arrangement. The alternating current rotor is provided with sliprings and the usual short-circuiting gear which latter is brought into use after the rotating element has commenced to revolve, but in the event of the machine ever having to be started from the alternating current and the sliprings and short-circuiting gear will come into operation in the usual way for alternating current starting. In any case, however, motor converter sliprings are always of small diameter and section as they are only in use at starting and in three-wire machines to collectively carry the out-of-balance current.

The guaranteed efficiencies are 93·5 per cent. at full load, 93·25 per cent. at three-quarter load, and 92·5 per cent. at half load. The temperature rise will not exceed 70°F. after six hours full load run and, when supplied with alternating current at 5,000 volts and with the direct current voltage at 505, the power factor will be unity at 90 per cent. of full load; at 540 volts and full load the power factor will be 0·97 leading, while at 485 volts and full load it will be 0·98 lagging.

The whole machine is of very massive and substantial construction, and the windings have been specially impregnated to withstand the climatic conditions obtaining in the country where it will operate. The magnet frame is divided horizontally and the complete rotating element very carefully balanced both mechanically and electrically.

It might, perhaps, be pointed out that the three 1,000 kw. Peebles motor converters, already mentioned as having been supplied to the Sydney Municipality run at 375 revs. per min. and, like the 2,000 kw. set, are each capable of dealing continuously with 25 per cent. out-of-balance current.

Installed in the same sub-station with two of the 1,000 kw. motor converters are two Peebles synchronous-motor-booster sets. As in the case of the motor converters the alternating current ends of these machines are supplied with three-phase current 50 cycles 5,000 volts, while the direct current ends are capable of giving 3,000 amperes at 0-187 volts.

Legal Intelligence.

Marconi Contract Litigation.

On Tuesday Sir Frederick Smith (Attorney General) mentioned to Mr. Justice McCardie the petition of Marconi's Wireless Telegraph Co. to the King, which was down for hearing before his Lordship. He said that he appeared with the Solicitor General (Sir Gordon Hewart), and that Sir Edward Carson was leading Counsel for plaintiffs. He was sorry to say that Sir Edward was indisposed and he could not possibly be there that day. Sir Edward asked his Lordship's indulgence to this extent that the case should be postponed till Thursday.

Mr. Justice McCardie, who said he greatly regretted the cause of the postponement, fixed the hearing for Thursday morning.

Liability for Tramway Trolley Accident.

In the Outer House of the Court of Session, Edinburgh, Lord Ormidale recently delivered judgment in two actions directed against the Lanarkshire Tramways Co. by Mrs. Mary Campbell (or Franeey) for herself and her four children, and by Thomas Adams. In the former action there were claims for payment of £1,300 in respect of the death of Alex. Franeey [illegible] while Adams claimed £300 for personal injuries.

The Lord Ordinary, who gave judgment for defenders, said that on Aug. 11, 1917, Adams and Franeey were outside passengers on defenders' tramcar, when an accident occurred as a result of which both were injured, Franeey succumbing on Aug. 31. [illegible]

[illegible]

Parliamentary Intelligence.

ELECTRICAL TREATMENT OF SEED.

[illegible]

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1916 SPECIFICATIONS.

[illegible] 371 ST. HELENS CABLE & RUBBER CO. & [illegible] [illegible]

15.366 LEITNER, H. & EXLEY, W. H. [illegible]

16.423 HENRY, R. & [illegible] E. [illegible]

17.261 MARTIN, A., WHITFIELD, J., CAMPBELL, T. B. & CAMPBELL, A. J. Method for [illegible] driven by electric motors differentially controlled. (1 12 16.) 112.963.

18.672 HARTMANN, J. F. G. P. Apparatus for transforming and especially for rectifying [illegible]

[illegible] rectification thereof.

1917 SPECIFICATIONS.

999 ELECTROMOTORS (LTD.), LONGBOTTOM, B., & GREENHALGH, E. Dynamo-electric machinery. (20.1 17.) 112.800.

1.110 STELL, N. Induction coils. (23 1 17.) 112.803

[illegible]

1.315 FLETCHER, F. P. Ovens and hot cupboards heated by electricity, steam, oil or gas. (26 1 17.) 112.821.

1.501 EASTERN TELEGRAPH CO. & DUNBAR, J. H. Means and apparatus for storing [illegible] (30 1 17.) 112.978.

[illegible] drivers and returned to their normal positions after the stored signal has been transmitted or retransmitted.

[illegible] machines. (4 2 16.) 104.172.

[illegible]

[illegible] application, 7.372 17.) 112.949.

[illegible]

8.690 WILLIS, H. S. & TAYLOR, H. A. Reflectors for electric bulb lamps. (11 8 16.) 108.670.

9.898 LAIDLAW, E. A., & GRINSTED, W. H. Electric transmission of signals. (9 7 17 addition to 1.653 17.) 112.897

[illegible] 112.911.

[illegible] cation on 17.275 16.) 112.913

[illegible] 111.837

[illegible]

Volunteer Notices.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Oxford-street, W. 1.

Officer Commanding: Lieut.-Colonel C. B. CLAY, V.D.

Orders for the Week.

[illegible]

Commercial Topics.

Non-Ferrous Metal Licences.

The President of the Board of Trade has appointed a Committee consisting of Sir Dudley Stewart Smith, K.C. (chairman), Sir H. Elverston, M.P. and Mr. H. J. Mackinder, M.P., to examine all applications for licences under the Non-Ferrous Metal Industry Act, 1918, and to report to the Board thereon.

Rules have been made by the Board of Trade under the Act, which prescribe the procedure to be followed in making applications for licences, &c.

* * * *

Coal Control.

An Advisory Committee has been formed by Sir Guy Calthrop, Coal Controller, to represent the public utility authorities of the County of London, and consists of :—

Messrs. F. C. McQuown (County of London Electric Supply Co.), [illegible] (West Ham Corporation Electrical Dept.), D. Milne Watson (Gas Light & Coke Co.), A. Stokes (South Met. Gas Co.) and A. L. C. Fell (L.C.C. Tramways).

* * *

Tin and Tungsten Research Board.

As the outcome of a conference held on Nov. 7, 1917, at which there were present representatives of the Committee of the Privy Council for Scientific and Industrial Research, of the Department for the Development of Mineral Resources, and many of the land and mine-owners of Cornwall, a fund for research has been raised, and a Research Board has been appointed by the Committee of the Privy Council consisting of :—

Sir Lionel Phillips, Bt. (chairman), Mr. John G. Gilbert (Cornish Chamber of Mines), Sir Frank Heath, K.C.B. (Department of Scientific and Industrial Research), Sir Thomas Kirke Rose (chairman of the Research Committee of the Board), Mr. Edgar Taylor (Institution of Mining and Metallurgy), Mr. R. Arthur Thomas (Cornish Chamber of Mines), and Sir Richard Threlfall, K.B.E., F.R.S. (Advisory Council for Scientific and Industrial Research), with Mr. A. Richardson as secretary (15, Great George-street, Westminster, S.W. 1.

The Board, after consultation with their Research Committee, have authorised extended lines of research with a view to increasing the [illegible] in the treatment of ores.

* * * *

Reorganisation Problems.

The Executive Council of the Association of Chambers of Commerce of the United Kingdom has passed a resolution criticising the Committees appointed by the Minister of Reconstruction.

The resolution states that these committees are for the greater part composed of persons who have not the necessary experience, knowledge or qualifications for dealing with the subjects referred to them. Therefore the Council declines to recognise the value of the finding of these Committees and record their want of confidence in the Minister of Reconstruction. The Committees criticised are :—

[illegible] to consider and report what action, if any, may be necessary to safeguard the public interest in view of the probable extension of [illegible] and combinations.

[illegible] to report as to any measures that can [illegible] that munition workers should be financially [illegible] after the war, and that reasonable [illegible] for metal losses as a result [illegible] in respect [illegible]

[illegible] to consider the best means of [illegible] for that purpose.

* * *

Automatic Telephony in South Africa.

[illegible] and apparatus [illegible] in South Africa.

[illegible]

Effect of War on [illegible]

[illegible]

duction of food during the war. The output of steel was about 10 million tons, compared with seven million tons before the war. With regard to coal, notwithstanding the withdrawal of 282,500 miners, the output for 1917 was 247 million tons, compared with 289 million tons in 1913, the home consumption being about 200 million tons, compared with 191 million tons. There was an increase of 68 per cent. in the Board of Trade units of electricity sold for the year to March, 1917, compared with the year to March, 1914.

The war had exercised a profound influence upon our foreign trade of the country. Over the period from August, 1914, to December, 1917, there was an excess of imports over exports amounting to £1,301 millions, or at the average rate of £372 millions per annum. The average excess of imports over exports for the three years before the war was £134 millions, but in considering the excess of imports over exports it must be remembered that the Board of Trade returns did not disclose what were termed "invisible imports and exports." In addition to carrying two-thirds of our own sea-borne trade and half the sea-borne trade of the world, we also financed and insured more than half the world's trade.

The advance in prices could not be fairly ascribed to the inflation of the currency ; it was entirely attributable to the war, which on the one hand produced intensification of demand, and on the other an obstruction of supply. Great as had been our achievement in the past 3½ years, a wider and more difficult task awaited us in the immediate future, but the splendid staying power and power of organisation of the British people inspired the belief that we should overcome the difficulties of demobilisation, and reorganise our industrial life in as complete and efficient a manner as we had organised for war.

* * * *

Electric Smelting Progress in Sheffield.

The annual report of the Sheffield Chamber of Commerce states that the past year has been one of unprecedented activity in nearly all branches of Sheffield trade.

The call for new types of steel was responded to with a promptitude which gave complete satisfaction to the authorities. The ever increasing demand for high-speed steel and for alloy steels for aeroplane construction is being effectually dealt with. A feature of the year has been a further and very considerable increase in local facilities for producing the open hearth heavier classes of steel, and a further important advance in making steel by the electric method may be reported. In several instances Sheffield has taken up successfully the manufacture of commodities which this country formerly obtained from enemy countries, and it is possible to report progress in making Great Britain independent of foreign markets as regards certain materials or finished goods.

Electricity Supply.

Extensions.

Bath. It is proposed to sell the Diesel engine set and to replace it by a turbo alternator.

Belfast.—Last week the Council in Committee decided by a majority of one to proceed with the erection of a new electric power house on the East Twin Island, at an estimated cost of £310,000, but subsequently the matter was postponed for a week.

In the course of a long report on the subject the consulting engineer (Sir John Snell) stated that the desire of the Ministry of Munitions, that the Corporation should give a large supply to Messrs. Workman, Clark & Co.'s extended shipyard, had entirely changed the position at Belfast. He had discussed the matter fully with the vice-chairman (Councillor Riddell) and the electrical engineer, and he also had a conference with Mr. A. B. Gridley (Director of Electric Power Supply) at the Ministry. He (Sir John) emphatically recommended the Corporation to give that supply to Messrs. Workman, Clark & Co. If the Corporation declined that responsibility, then they might give up all hope of developing the undertaking, for it was from future power supply that the main developments would arise, and it was only from such developments that a cheapening of the supply to existing classes of customer would be brought about. If the proposed new supply were granted the maximum load would not be less than 12,850 kw., and the plant installed gave a maximum output of 17,300 kw., leaving 4,450 kw. spare plant for three classes of supply—traction, general d.c. and the a.c. supplies. If the 6,000 kw. set broke down, it was obvious that there was insufficient reserve plant. The Corporation must take it, therefore, that the shipyard supply could not be given without a second 5,000 to 6,000 kw. turbo-alternator. He could not accept the possibility of giving the new supply without that second set, and he should even withdraw from his position as consultant if it were persisted in. The Corporation would, he felt sure, see [illegible] policy, and would decide to give the [illegible] supply and [illegible] install the necessary further plant by the end of 1919.

[illegible] possible, to put the plant into East Bridge-street [illegible] in the way of that project which would [illegible] The alternative was to put both [illegible] of the new branch station, when many [illegible] connected with East Bridge-street would disappear. [illegible] policy, but it meant a larger expenditure [illegible] would be difficulty in getting steel for [illegible] for the extra cable required. The [illegible] extension at East Bridge-street (two [illegible] expenditure recently voted (3 motors,

&c., £70,000), £126,000; or (b) (1) new harbour station (two 6,000 kw. sets) and connecting h.t. cables to East Bridge-street, £255,500, and (2) 8 rotaries, switchgear, h.t. cables East Bridge-street to Chapel-lane, &c., as recently voted, £55,250, a total of £310,750.

If two 6,000 kw. sets were fixed at East Bridge-street, he estimated that the Corporation could carry on until 1921 at the latest, but any other development such as that now before the Council in connection with Messrs. Workman, Clark & Co.'s shipyards would reduce the period and make the new station necessary at an earlier date. But at latest in 1921 the new station must be begun. The harbour site would mean an annual saving at once in the handling and saving of coal of £7,250, to which must be added the reduced cost of repairs and savings through higher efficiency all round, in boilers, condensers and pumping, of £22,000 per annum, at present prices due to the larger new sets. What he might call wasted capital in the East Bridge-street scheme amounted to £13,000, of which £6,000 was for a new 36-in. pipe and three special pumps. Interest and sinking fund on the extra expenditure of £175,000 for three years (at most) would be £42,000, and against that the [illegible] three years' [illegible] £7,250 [illegible] £21,750 [illegible] expenditure at East Bridge-street at least £13,000, [illegible] £34,750. Thus, if there was not likely to be any material reduction in the cost of plant between 1918-19 and 1921-22, the only extra cost to the Corporation in building the harbour station immediately [illegible] £7,000. The position in Belfast was really most difficult; had his recommendations in 1914 been then carried out those difficulties would have been saved. The Corporation was getting into even greater difficulties, which presently might become disastrous.

There was discussion on the [illegible] of the report, and an amendment was moved that in view of the magnitude of the proposed extensions and the large capital outlay involved, a special committee be appointed [illegible]. [illegible] 16 for and 16 [illegible] the Lord Mayor [illegible] vote against. It was then decided to adjourn the question for a week.

Leith.—The Council is recommended to install additional plant at the electricity works, including two new 1,500 kw. electric generators, at an estimated cost of £53,000 [illegible] plant and about £52,500 for [illegible] plant.

Pembroke (Dublin).—An inquiry was held last week into the application of the Council for sanction to borrow money for extensions of the electric supply undertaking.

Sheffield.—The L.G. Board has sanctioned the borrowing of £11,125 for railway sidings and [illegible] cables and auxiliary board, fans for boiler house, accumulators, &c., for the electricity undertaking.

Stoke-on-Trent.—The L.G. Board has been asked to sanction a loan of £7,340 for the electric supply department.

General.

Clapton (Yorks.).—The Urban Council has accepted the terms of Bradford Corporation for the supply of electricity.

Increased Charges for Electrical Energy.—The charges for current at the following places are being increased:—

[illegible] lighting company to increase its charge for current by a further 10 per cent., making the charge 6d. per unit, plus 20 per cent.

[illegible]

Rotherhithe Tunnel.—[illegible]

Stretford.—Negotiations are proceeding with regard to the probability of a demand for electric power, approximating 3,000 H.P., for a proposed factory.

Mr. J. A. Robertson, electrical engineer to Salford Corporation, has been appointed as consultant to advise in respect of a pending scheme of bulk supply. Mr. T. L. Miller has been appointed consulting engineer for a further year at the usual fee of £26. 5s. to cover the preparation of a quarterly report on the working of the station and [illegible] of the plant.

Wishaw.—The salary of the burgh electrical engineer, Mr. C. T. Astbury, has been increased by £50 a year.

Electric Traction.

Bournemouth.—The Corporation has decided to devote £3,000 out of past year's profits on the tramways to relief of rates.

Darlington.—In moving the adoption of the minutes of the Electricity and Light Railways Committee at the last meeting of the Corporation, Ald. Sir Chas. Starmer said there had been an increase in revenue on the light railway department [illegible] £2,000 on the year, and he hoped it would be [illegible] £3,000 before the year closed.

Doncaster.—The [illegible] electrical and tramways engineer, Mr. Robertson, has tendered his resignation to the Corporation.

Edgware and Hampstead Railway.—The London Electric Railway Co. has applied to the Board of Trade for an extension by one year of the times limited for the acquisition of lands and completion of certain works in connection with the construction of the line.

Electric and Petrol Vehicles.—The annual report on the operations of the Glasgow municipal cleansing department for the year ended May 31 last gives the following information in regard to petrol and electric wagons used by the department:—

Two petrol-driven motor wagons, each of 3 tons carrying capacity, have been used since the beginning of 1913 for the removal of domestic refuse. Whilst these wagons are advantageous in some respects, notably in the rapid transit of the material to the destructor works, the cost, due mainly to the numerous stoppages during the process of collection, does not compare favourably with horse haulage. The figures are: for motor traction, 3s. 9·52d. per ton and for horse traction 3s. 3·15d. per ton. Extensive repairs have again been required by these machines, and, on several occasions, they have been out of commission owing to the difficulty of obtaining materials for carrying out the necessary repairs. Experienced drivers and mechanics are difficult to obtain, and the machines are labouring under a severe handicap under present conditions. Two [illegible] electric [illegible] have been [illegible] put into commission on Dec. 13, 1916, and May 1, 1917, respectively, [illegible] period are 2s. 10·65d. per ton, compared with 3s. 3·15d. per ton.

Newport (Mon.).—The Tramways Committee recommend the extension of the tramway lines from the present terminus to the Channel Dry Docks, a distance of nearly [illegible].

Nottingham.—The chairman of the Tramways Committee, Mr. [illegible] announced at the last Council meeting that [illegible] the tramway fares will be raised.

Tramway Dispute.—The tramway dispute has been settled, and [illegible] of the grades concerned.

Telegraphy and Telephony.

Baltic Submarine Cables.—[illegible]

Guernsey State Telephones.—[illegible]

New French High Power Radio Station.—[illegible]

Miscellaneous.

American Hospital Train.—A hospital train, constructed at the Great Central Railway Carriage Works for the United States Army Medical Department, will be on view to the public at Marylebone passenger station to-morrow (Saturday) from 11 a.m. to 8 p.m. The charge for admission will be 1s., and the proceeds will be handed to the Red Cross. The complete train consists of 16 cars, and provides accommodation for 416 lying-down cases and 645 sitting-up cases. Every convenience and comfort that military medical officers can suggest has been provided.

Electrical Trades Benevolent Institution.—The appeals which have been made through the electrical press during the last few months are beginning to make themselves felt, for on March 1 the Electricals held a first class concert in aid of the funds.

The G.E.C., who have always liberally supported the Benevolent Institution, offered the use of their showroom for the concert. During the evening appeals were made by Mr. R. Howard Fletcher, M.I.E.E. (chairman of the Western Section of the Institute of Electrical Engineers) and Mr. W. A. Chamen, M.I.E.E., resulting in a sum of £23 being collected, promises made for other amounts, and new members joining. [illegible] now 17 members. We understand that the Bristol electricals, who are always in friendly rivalry, intend arranging something on similar lines in the near future and "going one better." Will other [illegible] please copy.

The Gattie Clearing House Scheme.—The Commercial Committee of the House of Commons has appointed a sub-committee to consider Mr. Gattie's scheme of a central goods clearing house for railways entering large towns.

Mr. Gattie recently attended before the Committee, and the idea is [illegible] experiment in a [illegible] town where the system could be applied to the work of the docks at little expense, or, alternatively, [illegible] be tried at some large provincial town, such as Leeds or Manchester.

Labour Demobilisation Problems.—The Minister of Labour recently appointed a large and representative Committee to advise him on the problems arising out of demobilisation of the forces.

The Committee will consider the questions connected with the resettlement of soldiers and sailors in civil life, and also the disbandment of munition workers. Mr. George Roberts (Minister of Labour) is chairman of the Committee, Lord Burnham vice-chairman, Mr. W. Windham, C.B.E., secretary, and Mr. H. C. Marks assistant secretary.

Manchester College of Technology.—The governing body have decided to alter the name of the Manchester School of Technology to the Manchester College of Technology.

Reyrolle's Roll of Honour.—In our issue of the 1st inst. we stated that 25 of the staff and employees of Messrs. A. Reyrolle & Co. had joined H.M. Forces. We are informed that 25 per cent. (and not 25) of the whole of the employees have joined.

Tenders Invited and Accepted.

Static Transformers.

Manchester Electricity Committee require tenders by 10 a.m. April 2 for the supply and erection of three 3,000 k.v.a. 33,000-volt three-phase static transformers. Specifications, &c., from Mr. [illegible] Town Hall, Manchester.

Electrical Stores and Fittings.

Tenders are required by first post March 18 for six or 12 months' supply of electrical goods to the [illegible] County Asylum, Park-[illegible]. Forms of tender from the Clerk of the asylum.

[illegible] require tenders by noon March 20 for [illegible] supply of electric lamps and fittings, engineers' sundries, &c. Forms of tender from the Clerk, [illegible] Prince-row, Buckingham [illegible], London, S.W.1.

[illegible] March 30 for [illegible] months' supply of electric [illegible] to the [illegible] Peebles [illegible]. Forms of tender from the Clerk and Steward, [illegible]

[illegible] March 21 for [illegible] Liverpool.

[illegible]

[illegible]

[illegible]

Business Items.

Messrs. Malcolm & Allan (Ltd.), of Kingsway House, Kingsway, W.C., who are well known as electric power, lighting and mechanical engineers, announce that, owing to their premises having been commandeered by the Government, they have moved to Goschen-buildings, 12-13, Henrietta-street, Strand, W.C.2; the stores entrance is at 31-32, Maiden-lane, Strand. The company's telephone remains Gerrard 4986.

Messrs. Malcolm & Allan (Ltd.), 499, Eglinton-street, Glasgow, have secured the sole agency for Scotland from Automatic & Electric Furnaces (Ltd.) for the sale of the Wild-Barfield electric furnaces and steel hardening equipment.

A new company, entitled Railless (Ltd.), has been formed to take over the patents and good will of the R.E.T. Construction Co. (Ltd.). The title indicates its objects and it will work the well-known R.E.T. system which has been operating successfully for several years in various towns, including Leeds and Rotherham at home, Boksburg and Bloemfontein in South Africa, and Shanghai in China.

Messrs. John Birch & Co. (Ltd.), 2, London Wall-buildings, E.C.2, have secured the export rights of Railless (Ltd.).

V.I.R. Cables.—A useful booklet, giving data and net prices (per mile, per coil and per yard) of V.I.R. cables, has recently been published by Messrs. Johnson & Phillips, Charlton, S.E.7. The booklet has been got out primarily to assist contractors in estimating work, and it should prove very useful for this purpose.

E.H.T. Transformers for Special Purposes.—A recent series of leaflets issued by Messrs. Johnson & Phillips (Ltd.) shows a number of special transformers, the construction of which is worth study.

The frontispiece shows a 100,000-volt type suitable for various applications where extra high voltages in comparatively small units are required. The series covers transformers from 50,000 to 150,000 volts, outputs down to 5 k.v.a. being supplied for 50,000 volts, and from 10 k.v.a. for higher voltages. Among the uses for such transformers are mentioned:—Testing dielectric strength, electro-culture and various electro-chemical processes. Other particulars refer to transformer pillars outdoor sub-station transformers, and transformers for test-rooms, laboratories and wireless installations.

Portable Electric Tools.—The Sun Electrical Co. (Ltd.), 118-120, Charing Cross-road, W.C.2, have just issued their revised list of Sun portable electric tools.

Particulars and prices of the series are given and the list includes grinders, drills and other labour-saving tools which are in use in the leading engineering works and aeroplane factories.

X-Ray Plates.—Messrs. Watson & Sons, 196, Great Portland-street, London, W., have issued a revised price list of their Sunic X-ray plates.

Liquidations, &c.

A meeting to receive an account of the winding up of the Immisch Launch & Boat Co. (Ltd.) will be held at the Manchester Hotel, Aldersgate-street, Lonon, E.C., on April 16.

Companies' Meetings and Reports.

Metropolitan Electric Supply Co. (Ltd.)

The 31st ordinary general meeting was held on Monday, Mr. A. W. Tait (the chairman) presiding.

The SECRETARY (Mr. F. Hipwell, F.C.I.S.) having read the notice convening the meeting and the auditors' report,

The CHAIRMAN stated that the gross revenue for the past year amounted to £318,216, an increase on that for the previous year of £40,307, or approximately 15 per cent. The increase in gross revenue, which was highly satisfactory, was to be accounted for to some extent by the increased charges which it had been necessary to impose upon the consumers to meet a part of the large increases in the cost of generation, particularly in coal and wages, and also in the cost of distribution. The greater part of the increase in revenue had been due to power supply. The progress in the Company's western area, where the largest power consumers were, had been very satisfactory during the year and had only been limited by the capacity of the existing plant and mains. The revenue from lighting still continued to suffer from public lighting restriction and from the Summer Time Act. The directors had hoped that economies effected during the year would have been reflected in the accounts, but those had been more than counterbalanced by the additional charges that had been put upon them. The award by the Ministry of Munitions of a 12½ per cent. increase in wages to certain classes in the engineering and shipbuilding trade caused considerable unrest among [illegible] generally, and the electrical workers petitioned that the increase should be made applicable to them. The supply companies were informed by the Government, in reply to their inquiry, that the electrical workers did not come within the scope of the award. As a strike was afterwards threatened, the Government ordered an arbitration before [illegible], and on [illegible] the award of 12½ per cent. was [illegible] to all [illegible] the employment of London supply companies, not [illegible] back to Oct. 13, 1917, and, in addition, the [illegible] of Production [illegible] additional 5s.

per week was also made applicable to them in consequence of pressure put upon the companies. Owing to the fact that the London supply companies were not invited to attend until after the arbitration had commenced the case of the companies could not be properly submitted, and that heavy increased charge was not only imposed but ante-dated, although it was pointed out that it was impossible for the companies to recover any portion of the same from their consumers until some time had elapsed. It involved a sum of not less than £10,000 per annum, apart from increases given to the staff. He was afraid, therefore, it would be necessary to make some further adjustment of charges to consumers in order that a portion of that additional charge might be recovered. The total expenses for the year amounted to £184,542, or an increase of approximately £23,500, which would have been greater but for economies effected. An issue of debentures (called Extension Debentures, 1917) to the amount of £500,000 had been created, and £250,000 had been issued. The debentures would be redeemed by means of an annual sinking fund, so that the whole of the issue would be extinguished by 1931—the date at which the London County Council had the right to exercise their power of purchase of a certain portion of their undertaking. Arrangements had been made for acquiring approximately the whole of the preference and ordinary share capital of the Uxbridge and District Electric Supply Co. as at Dec. 31, 1917, and the purchase would be completed immediately. An interim dividend at rate of 2 per cent. per annum was paid in August last, absorbing £10,000, and the directors recommended a final dividend at rate of [illegible] per cent. per annum, making a total distribution for the year of 4 per cent., absorbing £30,000, and leaving £4,926 to be carried forward. They were pleased to be able to recommend an increase in the dividend, [illegible] was accompanied by a substantial increase in the amount set aside to depreciation and reserve fund, and while the dividend could not be regarded as satisfactory, it was at least an indication of progress. He hoped when the war was over, if it was impossible to do so before then, the electric supply companies would seriously consider, in their own interests, as well as in the interests of their consumers, some plan of amalgamation of interests. He was more than ever convinced that the salvation of the situation and the proper development of the supply of electricity within the London area lay in that direction.

The motion for the adoption of the report and accounts was carried unanimously.

South London Electric Supply Corpn. (Ltd.)

The ordinary general meeting of shareholders was held on Tuesday, Mr. J. ATHERTON, chairman of the corporation, presiding.

The SECRETARY (Mr. Herbert Henry Boyer) having read the notice convening the meeting and the auditors' report,

The CHAIRMAN said the results of working, notwithstanding the difficult conditions under which the undertaking has been operated, are satisfactory, and they have only been obtained by the closest possible attention to every detail. The total receipts had risen from £59,037 to £66,656, an increase of £7,619, or nearly 13 per cent., but the expenditure has risen from £30,649 to £35,717, an increase of £5,068, or 16.5 per cent. By far the heaviest item in that increase is for coal, our expenditure for this having increased by £4,297, due not only to the cost at the pit's mouth being increased by Government order, but also to the greater output. The price of coal delivered on to our sidings is about double that ruling before the war, and the quality is very inferior, the ash contents being exceedingly high and involving increased costs for labour in handling. The capital expended during the year amounted to £13,572, the major portion of which was for new mains and conduits, it having been necessary, owing to the very heavily loaded condition of our feeders and distributors in the northern area, to augment the supply there. The opportunity was accordingly taken, when the County of London Company were laying their conduits for the bulk supply cables, to provide additional conduits for our own purposes [illegible]

[illegible]

the previous year, were nevertheless satisfactory, the equivalent of [illegible]

[illegible]

arise. To depreciation fund we have allocated £7,000, being the same amount as in the previous year, and there will then remain a balance of £3,425 to carry forward. The revenue for the year has borne the whole of the war expenditure incurred, including increases of pay and all bonuses to the workmen and staff to enable them to meet the increased costs of living, for active service grants, and for special aircraft insurance. You may, perhaps, have seen the reports and promises of future reports by committees sitting in connection with the Ministry of Reconstruction. It is, of course, impossible to forecast the recommendations which will be made, but it is not unlikely that proposals will come forward for the erection of super-power stations, supplying large areas, in place of small stations. You may rest assured that your directors will take adequate steps to safeguard your interests in relation to any proposals which may be made. Of our employees, 63 are with H.M. Forces, representing 42 per cent. of the number employed and over 70 per cent. of those of military age. The recent compulsory addition of 12½ per cent. to the gross earnings of our employees imposes a further serious burden on our expenditure, and our war percentage on accounts for electricity supplied has consequently had to be increased since the commencement of the year.

The report and accounts were unanimously adopted. The retiring directors (Mr. Renwick and Capt. Bax) and the auditors (Messrs. Price, Waterhouse & Co.) were re-elected, the proceedings terminating with a vote of thanks to the chairman, the directors and staff.

BOURNEMOUTH & POOLE ELECTRICITY SUPPLY CO. (LTD.).—At the meeting yesterday (Thursday) it was reported that the capital expenditure on the Bournemouth, Poole and Branksome, Christchurch and District and Pokesdown orders amounted to £2,239 in 1917, making the total expenditure £495,155. With £2,265 brought forward, the total amount available for the year was £38,120. Interest on debenture stock to Dec. 31, 1917, and interest on temporary loans absorbed £8,772, leasehold and special redemption funds and interest £2,112, and £8,000 was placed to reserve for depreciation, &c., leaving a balance of £19,236 available for distribution. Interim dividends on the 4½ per cent. preference and the 6 per cent. second preference shares, and on the ordinary shares at the rate of 5 per cent. per annum for the June half-year, amounting to £8,016, had been paid, and final dividends on the preference and second preference shares for the half-year ended Dec. 31, 1917, had also been paid, and a final dividend on the ordinary shares, at the rate of 7 per cent. per annum (less tax) was declared (making 6 per cent. for the year). The total applications received at Dec. 31 last amounted to the equivalent of 12,171 kw., an increase of 712 kw. for the year, and the total number of units sold for all purposes was 4,834,988.

BRUCE PEEBLES & CO. (LTD.)—The trading profit for the year 1917 amounted to £23,616 14s. 1d., and after deducting administration expenses, interest on the mortgage debentures, and allowing for interest accrued on the unsecured debentures and for depreciation, the net profit was £14,584 5s. 5d., which is subject to excess profits duty and control taxation for 1916 and 1917, the amounts of which have not yet been adjusted. The directors consider the results are satisfactory, having regard to the abnormal times and difficulties.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—The total capital expenditure at Dec. 31, 1916, was £2,656,540 and the expenditure during 1917 on additions, extensions and replacements was £5,839. The amount written off prior to Dec. 31, 1916, from reserve and from revenue [illegible] was £624,520 and the amount written off in respect of buildings, plant and other works dismantled during 1917 was £29,372, leaving the net expenditure at Dec. 31, 1917, £2,008,487, a decrease of £23,533 compared with 1916. The total of the reserves, including £17,574 proposed to be carried forward to 1918, is £350,431.

The total revenue for the year was £347,979 and with interest on investments and discount, &c. [illegible]

[illegible]

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.)—The capital expended during 1917 on account of the Company's London districts amounted to £45.123. 15s., making the net total expenditure in respect of these districts £2.234.187. 19s. 5d. The balance from the revenue account, after deducting generation and distribution costs, repairs, rents, &c., is £153,496, and with £18,378 from 1916 the total amount available is £171.874. Deducting interest on the first and second debenture stock and on temporary loans (£43,476) and amount carried to reserve for depreciation, &c. (£50,000), the balance for distribution is £78.398. Interim dividends have been paid (less tax) on the 6 per cent. fully-paid preference shares, and at the rate of 5 per cent. per annum on the ordinary shares for the half-year ended June 30. These interim dividend absorbed £26.812. 10s., and leave £51,585 for further distribution. The directors now recommend that a further dividend on the 6 per cent. fully-paid preference shares, and a further dividend on the fully-paid ordinary shares for the half-year ended Dec. 31, 1917, at the rate of 9 per cent. per annum (less tax) be declared, and that the balance of £15,023 [illegible] forward.

The applications received during the past year amounted to the equivalent of 4,551 kw., making the total at Dec. 31 last 69,132 kw. The total units sold were 37,595.261, against 35,029,862, an increase of 2.565,399 units. The number of consumers increased from 26,994 to 27,998. The directors of the Bournemouth and Poole Electricity Supply Co. have declared a final dividend on the ordinary shares at the rate of 7 per cent. per annum, making 6 per cent. for the year. The Coatbridge and Airdrie Electric Supply Co. has made further progress during the [illegible] units sold having increased from 8.414.823 units in 1916 to 10,072.535 units in 1917.

KENSINGTON & KNIGHTSBRIDGE ELECTRIC CO. (LTD.)—During the year 1917 the number of houses and shops connected with the system increased by 40 (from 5,070 to 5,110) and the energy consuming devices, [illegible] represented by lamps of 30 watts consumption, by 35,449 from 522,175 (15,665 kw.) to 557,624 (16,728 kw.). The number of units [illegible] million (494,522 or 10.5 per cent). The net profit for the year available for dividends is £13.224 15s. 10d. Adding £205 10s. 7d. brought forward and deducting the interim dividends at rate of 5 per cent. per annum on the ordinary shares, 6 per cent. on the first preference and 5 per cent. per annum on the second preference shares (£6.525), the balance is £6.905 6s. 5d., out of which must be deducted the second half-year's dividend on the first preference shares [illegible] £1,500, and provision for the dividend on the second [illegible] from Oct. 1 to Dec. 31 (£625), leaving £4,780 6s. 5d. Out of this the Board recommend payment of a dividend at the rate of 8 per cent. per annum for the last half-year, which will absorb £4,200, [illegible] dividend already paid 7 per cent. for the year on the ordinary shares. The amount to be carried forward is £580 6s. 5d.

NEWCASTLE-ON-TYNE ELECTRIC SUPPLY CO. (LTD.)—The connections [illegible] at the end of 1917 amounted to £297,079 H.P., [illegible] over 1916. The profit for the year (exclusive of any charge for renewals or improvements of plant) is £309,778. 18s. (against £263.957), from which has been deducted £60,000 carried to [illegible] and improvements, leaving £249,778 18s. (against £224,266). Adding balance brought forward (£7,434. 15s. 11d.), the total available profit is £257,213. 13s. 11d. (against £229,457). After [illegible] £60,606, and trans[illegible] depreciation and contingencies £60,000, the balance is £136,607. The directors recommend payment of a dividend [illegible] with the interim dividend [illegible] for the year £64,325, and a dividend [illegible] with the interim dividend [illegible] for the year £63,844, carrying forward [illegible] capital expenditure for the year amounted to £202,647, and represents further extensions at Carville and Dunston power stations, and of mains, &c. In April, 1917, the pre[illegible] 380,000 shares of [illegible] Durham Electric [illegible] the Cleveland [illegible]

[illegible]

[illegible] RAILWAYS CO. OF LONDON (LTD.)—[illegible]

[illegible] passenger service in London. It carried approximately 900,000,000 passengers a year, and the majority of the fares was 2d. or under. The future expansion and prosperity of that enterprise was secure, provided it is not interfered with. Their services gave to a large proportion of bread-winners their only means of access to and from their daily employment. They would not resent such additions to fares as were necessary to cover the increased expenditure; but they would resent such an addition to the fares as would give larger profits in war time than were previously obtained in peace time. The companies had increased and re-adjusted fares during the past year, so that each part of the system and each distinctive route of traffic between the fixed points should fairly contribute its quota towards the increased cost. The various companies would continue assiduously and vigilantly to presecute that work of adjustment. But the readjustment of fares in the case of season-ticket rates could not be made without the consent of the Board of Trade, as they controlled the District Railway. So far they had refused to allow an increase on season tickets on that line. The Company's income from the investments amounted to £606,730 against £653,361, which covered the payment of all fixed and cumulative charges and 4 per cent. for the year on the 6 per cent. Income Bonds. If the deferred maintenance of the properties in which they were interested could not rapidly be made good after the war, they invited, if they did not necessitate, competition. A review of the past inspired him with confidence as regards their future.

City Notes.

BROWETT, LINDLEY & CO. (LTD.)—A final dividend of 3 per cent. has been declared on the preference shares and an additional 4½ per cent. on account of arrears, making 10½ per cent. for the past year. A dividend of 6 per cent. is also recommended on the ordinary shares.

CAHIRCIVEEN ELECTRIC LIGHTING CO. (LTD.)—At the recent meeting a dividend of 10 per cent. was declared.

LANCASHIRE DYNAMO & MOTOR CO. (LTD.)—A dividend of 5 per cent. (tax free) has been declared on the ordinary shares.

W. T. GLOVER & CO. (LTD.)—The directors recommend dividends for 1917 at the rate of 5 per cent. on the preference shares and 5 per cent. and a bonus of 2½ per cent. on the ordinary shares. These dividends (less tax) will absorb about £10,210, and after allocating £6,500 to debenture redemption funds and transferring £20,000 to reserve, a balance of £10,770 remains to carry forward to next year, subject to excess profits duty.

WESTERN TELEGRAPH CO. (LTD.)—The directors have declared the second quarterly interim dividend of 3s. per share, tax free, for the year ending June 30, 1918, being at rate of 6 per cent. per annum. The transfer books of the company will be closed from March 16 to 23 inclusive, and the dividend will be payable on the 25th inst.

The Round Table.

By "kVA."

Electro-Harmonic Society.

SEASON 1917-18. LAST CONCERT.

To-night. Venetian Chamber, Holborn Restaurant.

Unofficial Programme.

In the Chair: "CARRY ON" WORDINGHAM.

DUG-OUT CHORUS ... "The Better 'Ole" *Before Bairnsfather.*
THE BRIGHTON ELECTRICAL WIND UPS.

[illegible] BALLAD "Rocked in the Cradle of the Deep" *SSH!*
ANY GOVT. OFFICE GIRL.

MEAT-COUPON SOLO "Boiled Beef & Carrots" *Offal!*
ANY RATIONED STOKER.

BOLSHEVIK PLAINTOVICH
"Are we down hearted, noo-hoo-hoo-ski" *Popoff.*
ADVERTISERS IN RUSSIAN EDITIONS OF TRADE PAPERS.

[illegible]
What the! How the! Why the! Who the! *[illegible]*
THE MUNICIPAL STATION ENGINEERS.

[illegible] "Is there nobody else to come?" *Per Pope.*
THE TUNGSTEN LAMP ASSOCIATION.

[illegible] "A Hundred Fathoms Deep" *Davy Jones.*
THE CREW OF THE LAST U BOAT.

[illegible]
[illegible] to be a Night that Night [illegible]
[illegible] ELECTRO-HARMONISTS.

GOD SAVE THE KING.

* * *

[illegible] electric lites received the following [illegible]

[illegible]

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

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CONTENTS.

NOTICE. GOOD FRIDAY WEEK.

"THE ELECTRICIAN" next week will be published on THURSDAY instead of on Friday.

Notes.

Joint Standing Industrial Councils.

Two further reports have just been issued by the Whitley Committee, the first dealing with Joint Standing Industrial Councils and the second on Works Committees. [illegible]

[illegible] of greater organisation. The recommendation is therefore made that such Trade Boards, possibly with larger powers, should be continued or established and it is felt that they would be useful, even in well organised industries, for certain districts where the organisation is not very complete.

Works Committees.

In regard to Works Committees, attention is called to the danger in unorganised or only partially organised industries that such Committees may be used, or thought to be used, in opposition to trade unionism. It is certainly important, as is pointed out in the Report, that such fears should be guarded against in the initiation of any scheme. Such Committees should not, in constitution or in methods of working, discourage trade organisations, but should work with them. It is recommended that regular meetings should be held, generally not less than once a fortnight, and that the Committees should keep in the foreground the idea of constructive co-operation in the improvement of the industry to which they belong. Practical proposals should be examined from all points of view, and suggestions of every kind tending to improvement should be frankly welcomed and freely discussed. Undoubtedly such Committees should not exist merely to smooth over grievances; their potential usefulness is much greater and should be applied in a constructive manner.

Automatic Generating Stations.

[illegible]

Interlinking in London

[illegible]

London Electric Supply Co.'s stations with that of the South London Electric Supply Co. A connection is already in existence with the Sutton station of the South Metropolitan Electric Tramways & Lighting Co., so that arrangements are in a fair way to completion for the interlinking of the companies dealing with electricity supply in the south of London. North of the river the position is much more complicated, as the areas are more remunerative and consequently are more split up. The systems are necessarily more diverse and it is a more costly matter to obtain interconnection except in certain cases.

Science in Education.—In reply to a question by Sir Philip Magnus in the House of Commons on Monday, Mr. Bonar Law announced that the report of the Committee on the Place of Science in Education would be laid on the table that day, and would be in the hands of members as soon as it was printed.

Street Lighting Specifications.—The standard clauses for street lighting specifications recommended in the Majority Report of the Street Lighting Specifications Committee (*see* "Journal" I.E.E., 1917, Vol. LV., p. 522) have now been published in pamphlet form. Copies can be obtained from the secretary of the Institution of Electrical Engineers, price 3d. each, or 4d. post free.

Ramsay Memorial Fund.—The Lord Mayor has issued a special appeal to the citizens of London for support to the Ramsay Memorial Fund. Of the £100,000 which the Executive Committee aims at raising, about £31,000 has been subscribed. It is to be hoped that all friends and admirers of the late Sir William Ramsay, as well as those interested in the advancement of chemical science, will subscribe to the fund. Subscriptions should be sent either to the Lord Mayor at the Mansion House or to the Honorary Treasurers of the fund (Lord Glenconner and Prof. Norman Collie), University College, Gower-street, London, W.C.1.

Royal Society.—With regard to our note last week on the candidates recommended for election to the Royal Society, our attention has been called to the fact that engineering has not been overlooked, in that Mr. A. G. Hadcock, a director of Sir W. G. Armstrong, Whitworth & Co., is an ordnance engineer. We understand that Mr. Hadcock has been responsible for the design of most important work in heavy [illegible] he represents engineering in one of [illegible] branches. Mr. E. Gold might also have been [illegible] physicist, though better known as a meteorologist.

British Engineers' Association.—The sixth annual general meeting of the Association was held on the 11th inst., Sir Wilfrid Stokes, K.B.E., president of the Association, in the chair.

[illegible]

[illegible]

Slow Filtration Pumping Schemes.—We notice among the [illegible] of the Corps of Royal Engineers [illegible] by Lieut.-Col. [illegible] on "Slow Filtration Pumping Schemes." The Paper [illegible] of the subject, special [illegible] which presents an instance of a scheme sufficient for the needs of a Division, and which was completed and supplied water within two months after the decision to encamp the Division in a certain area. Besides the engineering details given regarding the scheme, there is a complete statement of costs, while in appendixes there is a diary of the progress of the scheme, and a note on bacteriological tests of filtrates which will, no doubt, be of considerable interest to sanitary engineers.

Electricity and the Health of the Nation.—The second Chadwick lecture on "Electricity and National Progress" was given at the Albert Hall, Swansea, on March 15 by Prof. H. T. Davidge. The subject was "Electricity and the Health of the Nation." Four ways were indicated in which electricity may act as an aid to health. Firstly, electric traction enables the homes of workers to be placed in healthful surroundings, far from the fumes of the factory. Secondly, by lighting and heating those homes electrically the most healthy conditions may be maintained. These conditions might be associated with groups of houses possessing electrically-driven laundries, &c., and kitchens in common fitted with the best labour-saving appliances. Thirdly, electricity may be used as an agent for investigating the conditions of the body when disease is suspected, as in the use of X-rays and the lamps and other appliances used for internal examination. Lastly, we have the uses of electricity for curative purposes. Amongst the special treatments touched upon were diathermy, ionic medication, high-frequency currents, detection of foreign bodies, electro-cardiagrams, nerve and muscle reactions and obesity treatment.

Industrial Reconstruction Council.—The Industrial Reconstruction Council is holding the second of its series of important provincial meetings at the Assembly Hall, Edinburgh, on Wednesday, April 3, at 8 p.m. The Lord Provost will preside, and Dr. Addison, Minister of Reconstruction, will be the principal speaker. The object of the movement is to arouse a widespread interest in the recommendations of the Whitley Committee for the establishment of a Joint Council in every industry, and in view of the recent publication of the second report this meeting is particularly opportune. Applications for tickets should be made to the Secretary, The Industrial Reconstruction Council, 8, Bouverie-street.

Sir Charles Allom and Mr. Wilfrid Hill, a member of the Whitley Committee, have recently been added to the executive. The Council's explanatory pamphlet on "Trade Parliaments," which is the fullest explanation yet published of the Whitley Report, has, we understand, run into the third edition, and the demand is still greater than the supply. Negotiations are now proceeding for the establishment of local branches of the Council in all the leading industrial centres, and those who are interested in this important work, and are prepared to assist, will be welcomed by the committee.

Some Electrical Properties of Silver Sulphide.—A scientific Paper (No. 310), issued by the Bureau of Standards (Washington), summarises some researches by Mr. G. W. Vinal on the above subject. Silver sulphide may be prepared in the form of short wires or thin strips like a metal. The wire, which must be drawn hot, has been found to conduct electricity like a metal of high specific resistance, and has a practically zero temperature coefficient. The strip of sulphide, rolled at room temperature, has a large negative temperature coefficient, and shows both metallic and electrolytic conduction at the same time. It has a volt-ampere curve characteristic of a pyro-electric conductor. The resistance of these strips has been examined with both alternating and direct current, with the result that the alternating current resistance was nearly always found to be higher than that with the direct current, and the passage of a small alternating current of a frequency as low as 60 cycles increased temporarily the resistance of the sulphide, while a small direct current produced the opposite effect. The data obtained by the author were presented in the *Electrical World* last year, and referred to in these columns, but now form the subject of an official bulletin from the

Bureau. This Paper is now available for distribution, and those interested may obtain a copy by addressing a request to the Bureau of Standards.

Electrical Energy from the Volterra "Soffioni."—Towards the end of 1916 we referred to the interesting experiments being made by Prof. Luigi in Central Tuscany, on the generation of electric energy from the steam emerging from volcanic fissures ("soffioni") in that locality. Some additional details are given in a recent issue of "Engineering." These steam blasts contain borax and were originally used only for the recovery of this material. The chief problem in utilising the energy of the steam has been to avoid the corrosion from its ingredients. This has been met by applying the steam, not directly in turbines but to heat groups of low pressure boilers, whence steam from pure water feeds the turbines. Borax is collected from the condensed heating steam. The turbines are each of 4,000 H.P., coupled to 3,000 kw. alternators, current being distributed at 36,000 and 16,000 volts to Volterra, Massa, Sienna, Leghorn and Florence. It is now proposed to take this source of energy further in order to supply the important steel works at Alti Forni and the Magona d'Italia, at present using coal-raised steam. A scheme of treatment for the recovery of helium and other rare gases is also under consideration. While it is too early to judge of the economical results of the scheme it is stated that the company has sold more power than it can at present conveniently produce, and that the power available will be largely increased in the near future.

Ferro-Concrete Ships.—In a Paper before the North-East Coast Institution of Engineers and Shipbuilders, Mr. T. J. Gueritte recently gave some interesting details of the construction and qualities of ferro-concrete ships. The idea is less novel than many suppose, though it has received special attention since the outbreak of war. The author read a Paper on the subject in 1908; concrete barges and pontoons have been built in Italy since 1902; small rowing boats of this type were built by Lamjot in France as far back as 1849. It is very important that the concrete should be non-porous and, as far as possible, free from voids. Various systems of construction are being adopted. The Italian barges were plastered, *i.e.*, the cement applied as a coating to a steel framework, somewhat in the same way as ceilings of rooms are treated. Italians are clever plasterers and the method is cheap and expeditious, but moulding and casting methods seem preferable for larger vessels. [illegible] such vessels. Experience of concrete piers is very hopeful, [illegible]

The "Illuminating Engineer" Ten Years' Anniversary Number.—[illegible]

Mr. Gaster, to whose efforts the success of the movement is so largely due. Among those who have written are Mr. A. P. Trotter, Sir Wm. Crookes, Sir William Bennett, Dr. Louis Bell, Sir F. G. Kenyon, and David Murray, both Europe and America being well represented. We notice with special interest a letter from Dr. T. M. Legge, H.M. Chief Medical Inspector of Factories, who shows how the work of the Society and the Journal paved the way for the Home Office Departmental Committee on Lighting in Factories and Workshops. A recent statement of the Home Secretary, referring to the value of good lighting in factories at the present time, is also quoted. Among others, the gas and electric supply companies, and the chief makers of lamps and lighting appliances, are well represented. The conviction is generally expressed that there never was a time when the study of lighting was more important than to-day. After 10 years work this series of messages is a striking illustration of the prestige which the illuminating engineering movement now enjoys and the wide support it has secured. It is pointed out that this country led the way in Europe by establishing a Society and a Journal to deal with illumination. We can only echo the wishes expressed by the various writers, and wish both a bright prospect for the future and enduring success.

Obituary.

DEATHS ON ACTIVE SERVICE.—The following are reported as having died on active service:—

Rfm. Wallace [illegible] (K.R.R.), formerly engaged in the India Rubber Co.'s Silvertown works, is reported killed.

Sec.-Lieut. Geo. W. A. W[illegible] (R.F.C.), [illegible] on March 7, after having been at the front only a fortnight, was formerly an engineering student at Belfast University.

Personal.

Mr. M. W. Clarke, technical assistant and head of the testing department of Messrs. [illegible], Ltd. & Co., [illegible] for the past five years, is leaving to take up an appointment as chief electrical engineer to Messrs. Spencer & Co., [illegible] builders, of Melksham.

Mr. [illegible] W. W[illegible], M.I.E.E., has resigned his position as borough electrical engineer at [illegible], in order to take up an appointment on the 20th inst. as electrical engineer to the [illegible] Co., Avonmouth.

[illegible]

Arrangements for the Week.

FRIDAY, March 22nd (to-day).

[illegible]

SATURDAY, March 23rd.

[illegible]

TUESDAY, March 26th.

[illegible]

A National Proving House and Standardising Laboratory.*

(Concluded from p. 768.)

By Sir RICHARD T. GLAZEBROOK, C.B., F.R.S.

[illegible] 17 years ago I spoke in this room on "The Aims of the National Physical Laboratory." Much has happened since then. In 1901 the staff consisted of three scientific assistants working in some small rooms at the Kew Observatory, and the old Observatory staff; the income was perhaps £5,000. To-day—or rather from April 1st next—we shall be organised in eight different departments, each with its own superintendent and a large staff of scientific assistants and observers. The staff now numbers well over 500 persons, of whom about 180 are women. The expenditure during the current financial year will be considerably above £100,000. The enormous growth in expenditure from £38,000 in 1913-14 to over £100,000 this year is, of course, due to the war.

During this period the ultimate control of the Laboratory has rested in all particulars with the President and Council of the Royal Society.

From April 1st next there is to be a change. The scientific control of the Laboratory is still to be exercised by the President and Council of the Royal Society; the property of the Laboratory is to be vested in the Imperial Trust for the Encouragement of Scientific and Industrial Research—it is now vested in the Royal Society. The income of the Laboratory, including receipts from fees, is to be vested in, and is to be under the control of, the Committee of the Privy Council for scientific and industrial research. The Laboratory will be managed by an Executive Committee appointed as heretofore, and containing representatives of the great technical societies. In this manner it is hoped to secure financial stability, and to retain at the same time the great benefits which have come from the close connection with the Royal Society.

The Laboratory will endeavour to discharge two functions—it will be a Laboratory of Industrial Research and a National Testing Institution or Proving House. Industrial research—what is it? There must be institutions where research work is carried on for its own sake; but there is a wide gap between such homes of science and the works of the manufacturer, and it is to fill this that laboratories of industrial research are needed.

Abbé realised in 1876 that British optical instruments had reached the highest development possible until a radical change was made in the properties of the glass used for lenses. It took years of patient labour, aided by subsidies from the Bavarian Government, before he and Schott were able to place Jena glasses on the market. Von Bayer discovered synthetic indigo about 1880, but it was not till 20 years had passed that the Badische-Anilin-Soda-Fabrik produced it on a commercial scale. Long and patient inquiry was needed in the great laboratory of the General Electric Co. of America at Schenectady before the Coolidge tube was developed from the original X-ray tube. The work of the discoverer needs development and extension before it can be utilised by industry. This is the task of the Laboratory of Industrial Research.

Let me try to indicate some of the methods in which the National Physical Laboratory has endeavoured to fulfil such duties. Three such researches relate to the production of optical glass, the work of the Alloys Research Committee of the Institution of Mechanical Engineers, and the measurement of wind pressure on various struc- [illegible] On all these subjects much has been done. It [illegible] could be persuaded that in [illegible] the production of optical glass in England they [illegible] Nothing was [illegible] to key industries, but [illegible]

[illegible] to investigate the mechanical [illegible] comparatively in its infancy [illegible] the then recent work of Prof. [illegible] At the Laboratory the [illegible] alloys containing large [illegible] continuously pursued, [illegible] by Dr. Rosenhain. [illegible] of the Institution of Mechanical [illegible] of that work, of which nearly [illegible]

[illegible] special laboratory for [illegible] of the university [illegible] could be that [illegible] of the professor is to teach and to advance knowledge, that of the student is to learn how to research and to apply his knowledge. The professor will, no doubt, keep in close contact with the industry; but industrial problems are usually too complex for students, and, moreover, the answers are wanted too rapidly to make them subjects of a student's exercise. Moreover, the plant and equipment required is special; the industrial research laboratory must be fitted on the industrial scale. The requirements of students and the educational value of the apparatus need not be studied. There must, of course, be many specialised laboratories of industrial research—much more than the National Physical Laboratory is required; but the university and technical college laboratories cannot fill all our needs.

Another branch of the industrial research done at the Laboratory is closely connected with our original work on wind pressure. The Advisory Committee for Aeronautics was first appointed in 1908 by Mr. Asquith, as Prime Minister. It owes its inception to Lord Haldane, and much of the experimental work which it has initiated, and which has had so marked an effect on the efficiency of British aircraft, has been carried out at the Laboratory. When the tale of this work can be told it will form a striking example of the work of a Laboratory of Industrial Research, and the results obtained for purposes of war will bear fruit in the rapid progress of civilian aircraft.

The Froude Tank is another department of our Laboratory of Industrial Research. Built by Sir Alfred Yarrow in memory of Mr. William Froude, and for the service of the nation, he has had the privilege of seeing it repay its cost many times in the services rendered to naval warfare, as well as to naval architecture generally. Enough has been said to justify the claim that, though with scanty means, we have been a Laboratory of Industrial Research of real value to the nation.

And now, turning to the future, let us consider what is to be the position of the Institution as a Central Laboratory of Industrial Research. In referring about a year ago to such laboratories I wrote: "There must be more than one; in many cases an industry can be best served by a laboratory near its principal centre. Large firms, again, may each prefer to have their own trade secrets—this must be so to some extent—and trade jealousies may interfere with full co-operation; but a private laboratory on a really sufficient scale is expensive. Too often it becomes little more than what I have called a works laboratory for testing the products of the factory; and for the smaller firms, at least, the only way to secure the full advantage of scientific ad ance is by co-operation—co-operation in the laboratory, co-operation with specialisation in production, in the works themselves."

I do not wish to make the National Physical Laboratory not merely a natural but the only bridge between science and industry. The concluding words of the lecture referred to made this clear, special reference being made to the co-operation of trade associations.

The work foreshadowed in that lecture has already been begun. Various trades associations have been formed, or are being formed, for the promotion of research on matters of interest to the members of the trade. The principal objects of such an association may be briefly summarised thus

(*a*) To promote research in connection with the manufacture and use of . . . by maintaining or subsidising existing laboratories and workshops, or, if necessary, establishing and equipping laboratories and workshops.

(*b*) To retain or employ skilled professional or technical advisers in connection with the objects of the association.

(*c*) To encourage the discovery of, and investigate the merits of, improvements which may seem capable of being utilised for the purpose of the refractory industry, and to take out patents or licences relating to such inventions or improvements and to perfect and develop them.

(*d*) To support or to establish libraries, collections or museums necessary for the promotion of the industries concerned.

(*e*) To publish, or to assist in publishing, any literature, statistics, or information relating to the subject of . . . that may be of value to members of the association.

(*f*) To promote in any way desirable the education of those engaged or likely to be engaged in the industries concerned.

(*g*) To co-operate with other associations or bodies having objects bearing on the work of the association.

* Abstract of [illegible] Royal Institution.

(b) To apply to the Government for, and to accept, grants of money and other assistance for the purpose of the objects of the association, and to discuss and negotiate with the Department of Scientific and Industrial Research and other Government departments schemes of research and other matters within the objects of the association.

Each such association will probably require its own laboratory, situated, for preference, at the centre of the trade concerned. This will deal with the special problems of the trade, problems which need intimate association with works conditions for their solution, and for which the close supervision of men in works is important.

But there are numerous industrial problems which can best be dealt with in a central laboratory, such as :—

1. Investigations into methods of standardisation or of measurement generally ;

2. Investigation into the physical and mechanical properties of materials used in many trades ;

3. Investigations useful to a trade which has no fixed centre, but is widespread over the country.

Or, again (4), a central laboratory will be of service as a means whereby information as to large questions of general interest, investigated either at the central laboratory itself or at the local special laboratories, may be put into circulation.

A number of instances of work falling under these various headings were then quoted by the lecturer, such as researches on light aluminium alloys, various investigations on steels, the stress in crankshafts, material for valves of cylinders, lubricating properties of oil, refractories, &c. Such researches involve a laboratory that is complete, capable of chemical, physical and mechanical researches, with the necessary delicate and expensive apparatus, and a large and varied staff. Yet another piece of useful work quoted is the research that has been in progress for some time on the heating of buried cables.

Little need be said as to the fourth section of the work suggested for a National Industrial Research Laboratory.

The importance of the collection and dissemination of information on matters connecting industry and science is clear. At a central laboratory much of the information will be to hand ; the accumulated experience of the staff, their knowledge of the work done in the sectional laboratories, their appreciation of the bearing on industry, of inquiries in the region of pure science, are all valuable assets, and a proper organisation only is needed—by means of a Bulletin or in some such way—to circulate their information where it is most needed.

There is ample room for a central laboratory without trenching in the least on the spheres of the local sectional institutions. If the Department of Scientific and Industrial Research is to carry out effectively the work it contemplates, such a laboratory is essential, and the National Physical Laboratory may develop into such an institution in close connection, through the Department, with local laboratories throughout the country.

The Automatic Hydro-Electric Generating Station of the Iowa Railway and Light Company.*

By L. B. BONNETT.

Many automatic sub-station equipments controlling synchronous converters for railways have been put into service in this country, and the Iowa Railway & Light Co. has recently put into operation an automatic *generating* station. This station is hydro-electric and is located at Cedar Rapids, Iowa. It contains three vertical generating units with space for a fourth. The generators are each rated 500 k.v.a. two-phase 60 cycle 2,300 volt 60 revs. per min., and the water-wheels operate under a 10-ft. head.

Power is obtained from the Cedar River by a concrete dam above which there are automatic flashboards for raising the level an additional 3 ft. to make a total head of 10 ft. Each wheel is equipped with a motor operated gate and no oil pressure governor is used, the load being controlled through the motor-operated gate by a contact-making ammeter. Excitation is obtained from either one of two induction-motor driven exciter sets, each one being large enough for exciting the entire station equipment. These exciters are rated 100 k.w. at 125 volts, and are driven by 2,300 volt two-phase 1,200 revs. per min. squirrel cage induction motors.

The hydro-electric plant is some 3,000 ft. from the main steam generating station of the Company where there is an installed capacity of about 20,000 k.w. in turbine generators. The hydro-electric plant feeds its entire output into the [illegible] buses from which distribution is made. [illegible]

[illegible]

independently of the height of the water. For each hydro-electric unit there is also in the steam station a control button which, when opened, shuts down that generator and prevents it from starting again either from the steam station or the float switch until this button is reclosed.

The correct sequence of operations in starting is obtained by properly placed segments on the drum of a motor-driven controller. This arrangement definitely determines the proper time-spacing between the different steps of starting the unit and connecting its generator to the bus.

The closing of the float switch or of the remote control button in the steam plant starts the motor driving the controller drum. The first contact made closes a contactor which throws full voltage on the induction motor of one of the exciter sets. The motor is properly designed for this duty and comes up to speed in [illegible] seconds requiring about six times normal current. The exciter rheostat is set to give about 125 volts and the exciter builds up to [illegible]

Shortly after the exciter is started, another segment of the controller [illegible] 70 cycles. After opening the gate this amount the controller stops [illegible] A centrifugal switch mounted on the shaft of the generator is adjusted to close at about 55 cycles (55 revs. per min.). The closing of this switch starts the controller again, and after a definite interval of about two seconds, the generator is thrown on the bus without [illegible] the throwing of the generator on the line is adjusted so that the [illegible]

[illegible] leads. This is adjusted so that it opens the gate until full load [illegible]

[illegible]

[illegible] of the opening of the gate until the generator is connected to the bus with the reactance short-circuited. Within 45 seconds the generator is carrying full load. In spite of the speed with which these generators are connected to the bus, there is no mechanical jar perceptible. The generator causes only about twice normal current to flow when it is first connected to the bus without field, and the weak field pulls it into synchronism without serious surges.

An oscillogram taken of the current at the time one of the generators was thrown on the line is shown in Fig. 1. The first part of the film is of the current flowing when the generator is connected to the line without field, the next is of the current when the weak field is applied which soon pulls the machine into step. The field is then strengthened to normal. There now seems to be a tendency for the current to pulsate (this is presumably caused by the heavy reactance in series with the machine). As soon as the reactance is short-circuited the current steadies down in about 11 seconds.

When the float switch opens or the proper control button switch is opened, the contactors drop out disconnecting the generator from the line, the gate closes and the controller runs to the *off* position ready for the next operation.

The generators operate with a fixed excitation adjusted for normal full-load value. If the water level is so low that with full-gate opening normal load cannot be obtained, the generator due to its high excitation takes care of part of the wattless kilovolt-amperes of the system. The speed and voltage are, of course, determined

The oil switch connecting the tie cable to the steam station bus is equipped with inverse time-limit relays set for a current exceeding that which the hydro-electric generators are capable of giving on short circuit. This switch, therefore, will trip only in case of a short circuit in the cable between the two stations. If this happens, all contactors drop out because of low voltage on their coils. In the hydro-electric plant there is an emergency throw-over switch which, in case of failure of voltage on the main cable, transfers the control circuits to a separate source of power from the steam station. This furnishes energy for closing the gates of the water-wheels, and the machines are shut down until the voltage returns on both phases of the incoming cable. Then, provided the control buttons are in the correct position, the generators start again and pick up their load.

The operator accidentally tripped the switch in the steam plant when one of the generators was carrying load. In less than two seconds the generator tripped out its contactors because of overspeed, and the gate was closed obtaining power from the separate source by means of the automatic throw-over switch.

Recently, the exciter of the steam station failed while the automatic plant was running. As the hydro-electric plant is much too small to carry the total load, it should not only disconnect itself from the load but should close its water-wheel gates. This is exactly what happened. The failure of the exciter in the steam station caused increased current to flow in the hydro-electric generators. The contact-making ammeters on these generators immediately

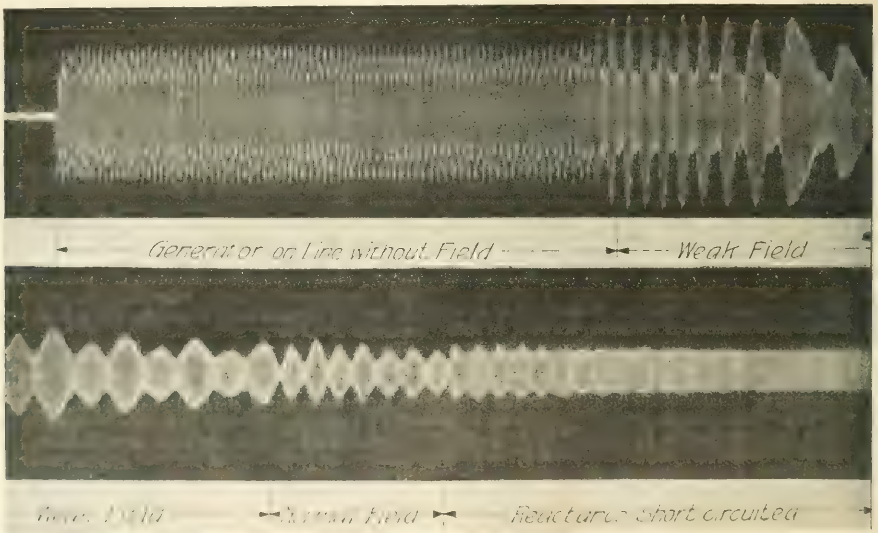

FIG. 1.—OSCILLOGRAM OF THE CURRENT FLOW BETWEEN GENERATOR AND LINE WHEN A UNIT IS BEING PLACED IN SERVICE.
[illegible] the time the machine is satisfactorily carrying its share of the load (the lower part being a continuation of the upper).

[illegible]

started the closing of the gates, and almost completely closed them before the voltage of the system dropped too low.

Under normal conditions the load was found to be steady, varying only as the water level changes, so that there was no tendency of the contact-making ammeters to keep the gates in motion. The steam station takes care of all fluctuations of load.

There are no instruments in the hydro-electric plant, all indicating and totalising meters being in the steam plant station.

The station will be operated at its full capacity at times of peak load, being started and stopped from the steam station, so that the latter may be run at a more nearly constant load with consequently more efficient operation of the boilers. At other times the generators will be normally controlled from the float switches.

The cost of an automatic control equipment similar to this is not greatly in excess of that of the ordinary hand control switchboard. The control equipment is simple, and consists of contactors and other material whose reliability has been proven in many years of use under severe conditions of frequent operation. Where a hydro-electric plant is auxiliary to a larger station, such an automatic equipment with the saving in operating expenses and the most economical use of the water may spell the difference between loss and profit in the operation of the plant.

The Measurement of the Permeability of Iron Stampings by Ewing's Double Bar and Yoke Method.

By FRANK SHAW, B.Sc., B.Sc. (Eng.), M.Sc. Tech., A.M.I.E.E.

Summary.—The article describes a number of experiments undertaken to demonstrate the applicability of Ewing's method for the determination of the permeability of laminated specimens of steel. The methods of preparing the specimens and determining the cross section are discussed, and some remarks are added on the calibration of the ballistic galvanometer. A number of the results obtained are compared with those of other investigators. Finally attention is drawn to the importance of the layer of scale formed on mild steel during the process of rolling and the effect of this on the results obtained for permeability.

Introduction.—The method most commonly described for the measurement of the permeability of iron stampings necessitates the specimen being obtained in the form of rings. The advantage of this form lies in the fact that the value of magnetising force can be accurately calculated from the current and turns per centimetre. There are two practical objections to using ring specimens. Firstly, the rings have to be wound by hand, both with magnetising and search coils. It is true that this difficulty may be overcome by employing the special apparatus devised by Möllinger, in which the magnetising coils are divided and the turns attached by means of connectors. But in this case, the number of turns cannot be made very large, and it is usually at high values of flux density that the value of permeability is required to be known in the case of punchings. The second objection lies in the waste of material caused by punching out the rings. In order that the variation of magnetising force across the section of the ring may not be considerable, the radial thickness must be kept small and, therefore, a considerable number of stampings must be used to secure the necessary cross-sectional area. To overcome these objections various methods have been employed, in which the specimens are in the form of straight strips. The condition of endlessness is secured to a greater or less extent by means of heavy yokes which connect the ends of the bars. In permeameters like that of Hopkinson, the cross-section of the yoke is made very large compared with that of the specimen, so that the fall of magnetic potential in the yoke may be negligibly small. There always remains the air gap, however, and the number of ampere-turns required to magnetise this is not readily calculable. The special feature of the double bar and yoke method suggested by Ewing, lies in the novel method of correcting for the reluctance of the yokes.

Method of Test.—In Ewing's method the reluctance of the gap and yoke is allowed for in an ingenious manner. Two sets of magnetising coils are employed, one pair being twice the length of the other. The two long coils should have the same number of turns; also the two short coils. Further, the long coils should have about twice the turns of the short coils [illegible] [illegible] of this density in the specimen. If the ballistic galvanometer is provided with a long focus mirror, *e.g.*, 2 mètres, it will be found that, as a rule, the throws are sufficiently nearly proportional to flux-turns to render corrections unnecessary. It is possible in using a ballistic galvanometer to obtain results which agree within one part in a thousand, but for the purpose under discussion such accuracy is not warranted. The variations of the magnetic properties of the iron at different parts of the sheet and the thickness of the scale are two factors which seem to preclude a high degree of accuracy being obtained.

Details of Apparatus.—The apparatus shown in Fig. 1, was made up at the Manchester School of Technology, for the determination of permeability of sheet iron by the double bar and yoke method. Secondary coils were wound over the brass formers and underneath the magnetising turns. Owing to the thickness of the former and the insulation, the correction for air lines with this arrangement was rather large. The mean area of the search coil was 7·72 sq. cm., so that with a specimen of net cross-section 2·5 sq. cm., it is necessary to subtract $5{\cdot}22 \times H$ lines from the total flux. Thus with $H = 1\,000$ and $B = 20{,}000$, the correction for air lines amounts to 10 per cent. An error of 1 per cent. in the area of the search coil

FIG. 1.—APPARATUS FOR TEST WITH DOUBLE BAR AND YOKE METHOD.

would, therefore, give rise to an error of 0·1 per cent. in the final result. This does not seem important in view of the other variable quantities, but it is perhaps doubtful whether [illegible]

[illegible]

[illegible] method.*

* [illegible]

The [illegible] of correcting for the reluctance of the gaps and yoke is well known, and the proof on which it depends will be found in many advanced text books.* If the reluctance of the gaps and yokes is constant, the horizontal distance between the long and short curves should vary directly as B. Fig. 2 shows how nearly this result can be realised in practice. For high values of H it is difficult to obtain points on the long and short curves lying in the correct relation. One reason for this is that the heating up of the windings causes the temperature of the iron to vary. With specimens of the size adopted, the correction for the yokes and joints is negligibly small above $H=100$, so that the "long" and "short" curves become practically co-incident. Fig. 3 serves to illustrate this.

Method of Working.—For quickness in examining a number of samples, the writer has adopted the following procedure. The ballistic galvanometer is connected in series with the search coils, the coil of a Hibbert Magnetic Standard and a resistance box. The cross-sectional area of a particular specimen is first obtained. The number of turns on the specimen is so arranged that for high values of flux density to the next may affect the deflection produced in a different way from what it should, this with the brass contacts apparently in proper condition. Careful cleaning with brass polish has caused this effect to disappear. The importance of clean contacts may be due to the smallness of the E.M.F.s set up in the secondary circuit.

The Hibbert Magnetic Standard.—For calibrating the ballistic galvanometer the writer has found the Hibbert magnet most convenient. The coil belonging to this standard is always kept in the galvanometer circuit, so that it is a simple matter at any time to take a check reading. At various times the standard magnet at the School of Technology has been carefully checked against a standard air coil, and good agreement has always been obtained. Notwithstanding what has been said, the Hibbert Standard is capable of giving quite erroneous results. It has been found, for instance, that if one of the coils has not been used for some months, there is a tendency for the brass tube to bind on the spindle. The result is that when released the coil falls and rebounds a little from the rubber pad and sticks.

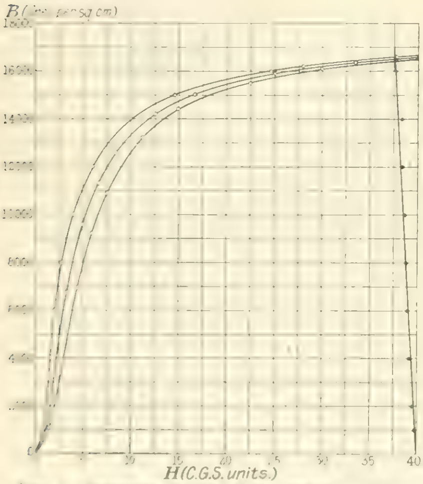

Fig. 2.—[illegible] Permeability Curves obtained by [illegible] Method.

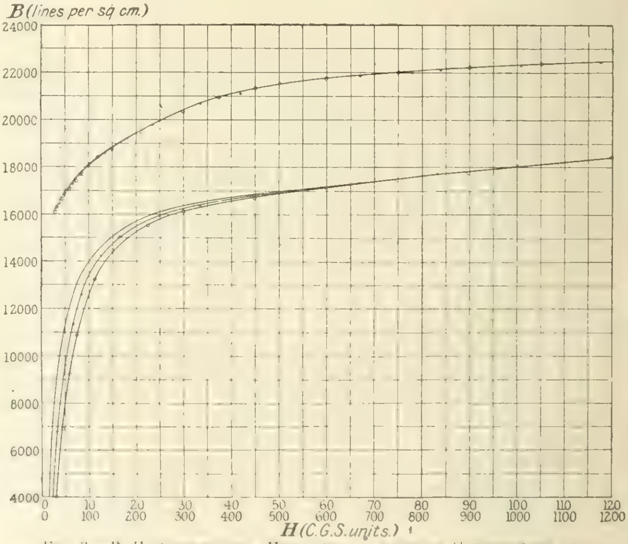

Fig. 3.—B.-H. Curves for Mild Steel, showing Convergence at High Flux Densities.

[illegible] deflection is produced on the galvanometer when the magnetising current is reversed. The galvanometer scale [illegible] long, and divided into [illegible] divisions, each being [illegible] in. [illegible] The resistance of the circuit is so arranged that the flux density in the specimen is exactly 100 times the throw. For this condition to be realised, the Hibbert magnet must produce a certain throw on the galvanometer, the magnitude of which is readily calculated. The writer has found from experience that it is best to use a scale with zero at one end and [illegible] deflections in both directions. Before taking a reading, the galvanometer should be allowed to deflect [illegible] the reading expected. The galvanometer [illegible] the zero line. If this precaution be taken the galvanometer will come to rest in the same position after each throw. In order that the resistance of the galvanometer circuit may be adjusted to a suitable value, a resistance box either of the plug or dial pattern should be included. It has been found that great care must be taken to keep the contacts [illegible] dial pattern [illegible] of the current from one stud

When the spindle and tube are cleaned and polished, the same rebound may take place, but the coil quickly settles down to its place. The figures given below show how misleading the results may be if this matter is not attended to. The two sets of observations were obtained without altering the circuit in any way.

Before cleaning	197	...	196·6	...	197	...	197·5
After cleaning.........	200	...	200·1	...	200·2	...	200·1

Determination of Density.—In order to obtain the cross-sectional area of a sample under test, it is necessary to determine first the density of the material. This is done by weighing specimen plates in air and water. Care has to be exercised to free the plates from grease, otherwise it will be found almost impossible to remove air bubbles when the plate is being weighed in water. The best method of removing grease is to thoroughly soak the specimen in benzine. The cross-section is, of course, obtained by dividing the mass by the density and the length.

Since the weight and density of the plates is that of iron and scale, the cross-section obtained is also that of iron and scale. The greater the thickness of scale the lower will be the density. Moreover, the value obtained for permeability

will depend on the amount of scale present, and since the magnetic properties of scale are inferior to those of pure iron the greater the amount of scale the lower will be the flux density produced by a given magnetising force.

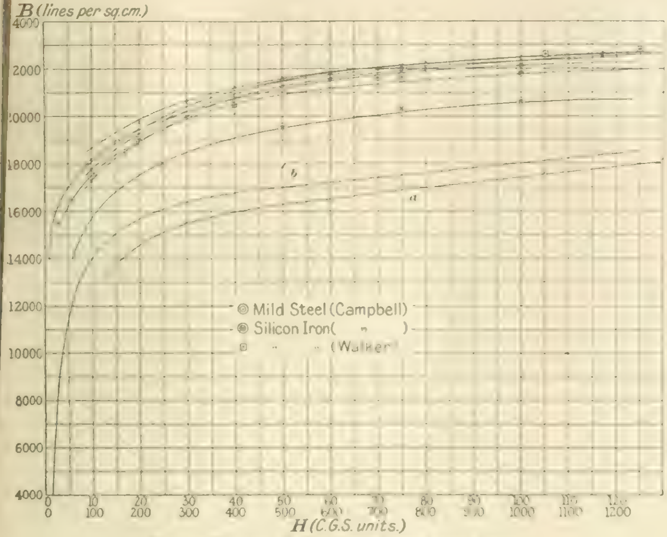

Fig. 4.—Typical B-H Curves for Sheet Steel.
—⊙—⊙— a [illegible] and d
b [illegible] and f

How widely the density of plates varies will be evident from the table below. All the specimens tabulated are "dynamo steel."

Reference letter.	Description.	Density.	Remarks.
a_1	Plates cut across grain	$7{\cdot}77_7$	[illegible]
b_1	Plates cut parallel to grain	[illegible]	[illegible]
c_1	Plates cut across grain	$7{\cdot}82_6$	[illegible]
c	Plates cut across grain	[illegible]	[illegible]
d_1	Plates cut parallel to grain	[illegible]	[illegible]
d	Plates cut parallel to grain	[illegible]	[illegible]
d_1	Plates cut parallel to grain	[illegible]	Selected as having little scale.

The scale was afterwards carefully removed from the specimens d, and d_1 and the densities again determined. The results were:

d	[illegible]
d_1	7·881

Showing that the variations in density are accounted for by the difference in the amount of scale on the specimens.

In a recent publication* the Washington Bureau of Standards distinguishes between high and low resistance steels. Low resistance steels are defined as those having a resistivity of about 1 ohm per metre-gram. High resistance steels are classed as those whose resistivity is between [illegible] and [illegible] ohms per metre-gram. All the results given in the present article refer to low resistance steels. The resistivities of samples [illegible] and [illegible] were found to be [illegible] and [illegible] per metre-gram respectively. At the Bureau the cross-sectional area of a specimen of one of these steels is determined on the assumption that the density is [illegible]. The figures given above serve to show that considerable error may be introduced by assuming a fixed value for density.

Low resistance steels contain a small proportion of silicon. Mr. [illegible] has been good enough to analyse some of these specimens for me. For the samples a and b, which are the same material, but cut differently, the silicon was 0·16 per cent. The specimens c and d, which are also the same brand, showed about 0·13 per cent. silicon.

Permeability Curves of Commercial Samples.—In Fig. 4 are given results obtained by testing some samples of commercial sheet steel. In the cases of the samples e and f the specimens were assembled so that half the plates were [illegible] to the direction of rolling and the other half perpendicular to this direction. The two lower curves in Fig. 4 show the values of B and H for a specimen of steel measured perpendicular (a) and parallel (b) to the direction of rolling respectively, the values of H to be read on the top scale. As is generally supposed, the material becomes magnetised more readily in the latter case, the divergence tending to diminish however, at high inductions. With the samples c and d the action is peculiar. At low inductions this specimen behaves as the steel just referred to, but at about $H=300$ the curves cross and the permeability measured across the grain is apparently greater than that measured at right angles. Whether with this brand of steel this result is general it is not possible to say at present, but a repetition of the test failed to disprove this peculiar result for the two samples supplied.

For purposes of comparison I have added to this diagram the curves for electrolytic iron and mild steel, published by Messrs. Campbell & Dye,* also the curve for sheet steel published by Prof. Walker in his book on "Dynamo Design." It is interesting to notice that the curves for these materials included in a recent Bulletin† from the Washington Laboratory coincide exactly with those obtained at the N.P.L.

The curves published by Messrs. Campbell & Dye are obtained by a special method which they have selected

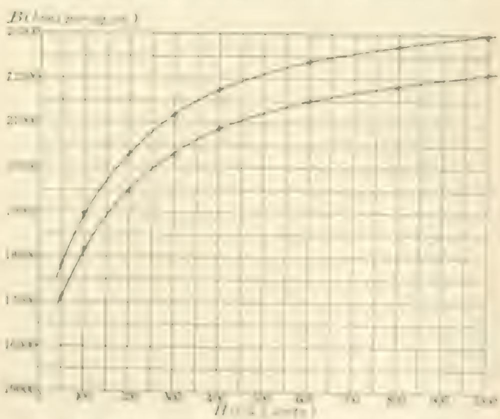

Fig. 5.—B-H Curves for the same Specimens of Steel.
[illegible]

This is a modification of the "[illegible]" method suggested by Ewing & Low. The method is admirably adapted for measurements at high inductions, but it is, perhaps, open to doubt whether the accuracy obtainable is as great as in the case of the method described here.

A very interesting test to apply to all results for permea-[illegible]

*"Magnetic Testing," No. 17, March, 1916.

* [illegible] Dec., No. [illegible], December 1915.
† "Magnetic Testing," No. [illegible]

bility is the comparison of the values for intensity of magnetisation. With the usual symbols $J = \frac{B-H}{4\pi}$, Prof. Ewing stated some time ago that for pure iron J tended to a maximum value just below 1,700. For the electrolytic iron tested by them, Messrs. Campbell & Dye find J to be 1,717. The best specimen of iron in the series recently examined gave B=22,500 for H=1,000, *i.e.*, J=1,710. The specimen of steel from which the scale was removed as described below gave B=22,900 for H=1,000 or J=1,743, which is higher than the results obtained by Messrs. Campbell & Dye. I have tabulated below the values of J obtained from time to time by different observers.

Values of J Found by Different Observers.

Ewing & Low (Low moor iron, isthmus method).......	1,700
Ewing & Low (Low moor iron, isthmus method) 1,630–1,740. Mean value	1,700
Du Bois (optical method)	1,700–1,750
Gumlich (isthmus method, electrolytic iron)......	1,725
E. F. Clark. Low moor......	1,667
E. F. Clark. Swedish	1,680–1,690
Campbell & Dye (isthmus method, electrolytic)......	1,717
B. O. Peirce (Norway iron)	1,740
Miles Walker (dynamo sheet steel)	1,714

Effect of Scale on Sheet Steel.—That the scale left on sheet steel after rolling reduces the effectiveness of the material is well known, and designers and others have to make an allowance for it in calculating the area of a magnetic circuit. The usual custom is the one adopted here, viz., to divide the total flux by the cross-sectional area of the material and call this the flux density. An alternative method would be to obtain permeability curves for pure iron, *i.e.*, iron with the scale removed and subsequently allow a certain percentage of the cross-section for scale, paper and air.

The thickness of the scale appears to be a very variable quantity; in some cases it is merely a thin film, less than 1 mil thick, whilst in others it is so thick that when a plate is bent the scale falls off in flakes. One can generally tell from the appearance whether the scale is thick or not. The following figures serve to show the order of magnitude of the thickness. The first eight measurements show the thickness of a plate of mild steel, obtained with a micrometer placed at different parts of the plate from which the scale was subsequently removed.

Thickness with scale (mils)	18½	19	21½	20	19½	20½	19	18½
Thickness without scale (mils)	16	16	16	16	17	16½	17	17

The scale was removed by rubbing the plate with a carborundum slip, and care was taken so that practically no iron was removed. The average thickness was 19 mils with scale and 16½ mils without, so that the scale accounted for 15 per cent. of the original thickness. It will be noticed incidentally that the thickness of the plate is more uniform after removing the scale. It must be remembered that the plate chosen was a bad specimen.

A more satisfactory way of estimating the effect of removing the scale from sheet was to carry out a permeability test on the material as supplied and then to completely remove the scale from the plates and test again. To carry this out [illegible] plates forming the specimen were subjected to [illegible] in the usual way. The scale was then removed from each plate. This proved an exceedingly laborious [illegible] possible [illegible]. The plates were rubbed with the carborundum slip and finally polished with emery paper. The removal of the scale reduced the weight of the plates by about 10 per cent. The plates were assembled [illegible] and [illegible] the [illegible]. In Fig. 5 the two curves are plotted. The following figures taken from the curves show the ratio of the [illegible]:—

H	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
B_1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
B_2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ratio	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

This means that for a particular cross-section of magnetic material (as determined from weight and density) a given magnetising force produces 4 per cent. more flux with clean iron than with iron covered with scale.

The experiments described in this article were carried out in the Electrical Research Laboratory of the Manchester College of Technology, and I wish to acknowledge my indebtedness to the Governing Body and the Principal for the facilities placed at my disposal. Many of the experiments were suggested by Prof. Walker, who has at all times given me the benefit of his experience.

The Work of the Electric Vehicle Committee.

Although it is some little time since a report was issued dealing with the work of the Committee, it must not be inferred thereby that the latter has ceased its activities. From the beginning of July, 1917, up to date there have been five meetings of the Committee, including sub-committees. The Committee's efforts have been mainly directed to negotiations with Government Departments with a view to facilitating the extended use of commercial electric vehicles by an increase in home construction and a modification of import restrictions. The Committee's efforts have not been unfruitful, but it is hoped that some further concessions may be obtained in the future, having in view the beneficial effect that the extended use of electrics would have in the matter of conserving grain and petrol supplies. It may be mentioned that the maintenance of all electric vehicles in service for utility and national work is strongly supported by H.M. Petroleum Executive on grounds of petrol economy.

The Committee has been in close consultation with the Ministry of Munitions as to fuel economy, and upon the question of the allocation of lead for lead-plate batteries. In view of the great demand for lead for war purposes, the Committee has obtained a promise from the Munitions Overseas Transport Department to allot shipping space up to a total of 6 tons per week for the import from the United States of America of lead battery plates for electric vehicles. It was at first proposed that battery plates should be brought over and allocated through a firm of accountants acting on behalf of the Electric Vehicle Committee; but a consideration of the question by a special sub-committee led to a decision that it would be preferable to let the battery and vehicle makers apply, with the support of the Committee, within the approved weekly limit of weight, to the respective Government Departments concerned in import and shipping questions in respect of any batteries that may be required.

In July the Committee was requested by the Mechanical Transport Department of the Ministry of Munitions to co-operate in a scheme proposed by the Director of Mechanical Transport for getting more electric vehicles put into service, with a view to saving petrol, and a concomitant to this scheme was a proposal to provide facilities for the building of electric vehicles in quantities by certain British firms and the import of vehicles from the U.S.A. The Committee met in conference with the Director at the Ministry, and discussed his proposals in detail. At the request of the Department, and in connection with the scheme, the Committee collected information from local authorities as to motor vehicles in use and those on order, and generally went to a great deal of trouble in the matter. Owing, it is understood, to the increasing stringency of the steel position for war purposes, the contemplated scheme did not admit of adoption.

The Committee has from the first hoped for the harmonious co-operation of motor traders and electric supply authorities in promoting and facilitating the adoption and use of the electric vehicle. In some quarters there have been signs of opposition on the part of the motor traders to electric supply authorities taking up the care and charging of electric vehicles; but this is proved to be due to a misunderstanding of the position, which, now that the motor manufacturers and motor traders are represented on the Committee, it is hoped to remove, with resulting harmonious co-operation between all interests. To this end a joint meeting is being arranged of the council of the Motor Trade Association and the Electric Vehicle Committee.

The Committee's aim has been to make its constitution as completely representative as possible of all interests concerned, and, in accordance therewith, the following members have been added:—

Mr. Goodwin (managing director of C. A. Vandervell & Co., Ltd.), as representative of the Motor Trade Association.

Mr. H. Wyatt, as representing the British Motor and Allied Manufacturers' Association.

Mr. J. P. Kemp, as representative of agents for electric vehicles.

Mr. P. Still, who has been a member of the Committee from its early days, as representative of the Chelsea Electricity Supply Co., now becomes, by the consent of 9 out of 13 companies, the representative of London electricity supply companies on the Committee.

United Newspapers, Ltd., Staff Dining Kitchen.

Considerable interest is being shown by newspaper proprietors in London in the use of electric cooking apparatus for providing teas and meals for the staff. The proprietors of "The Daily Chronicle," "Lloyd's Weekly News," etc., United Newspapers, Ltd., Salisbury-square, London, some months ago instituted a staff dining room with an

FIG. 1.—ELECTRIC KITCHEN.

electric kitchen, which we understand has proved a great success from the electrical point of view [illegible] particularly by those members of the staff [illegible] during the late and early hours. [illegible] a kitchen equipment and the arrangement of the dining room, which

FIG. 2.—DINING ROOM.

[illegible]

[illegible]

on the same table is a cast-iron type grill with open element loaded to 800 watts. The apparatus is fixed at a height which obviates stooping, and the walls of the kitchen are lined with glazed brick, so that the place can be easily kept clean. The installation is connected up to the power mains in the building, the cables being laid in screwed conduit, and the controlling switches are of the ironclad pattern. All metal work is carefully earthed. The apparatus provides teas in the afternoon and meals for the night staff, and about 120 meals are served during the period the dining room is open. A somewhat similar "Tricity" equipment, which includes also provision for warming up meals for the workers, is installed in another part of the building where the manufacture of war material for the Ministry of Munitions has been carried on for the past three years. The management are to be congratulated upon their enterprise in providing these facilities for the staff and workpeople, and also upon their foresight in adopting an electrical apparatus which fits in uniformly with the electrical character of the printing equipment; at the same time, by the use of this apparatus, they are enabled to save considerably over coal and gas.

We need hardly remind our readers that the electric power and newspaper printing installation of United Newspapers, Ltd., is one of the most modern in Fleet-street or elsewhere. Under the guidance of Mr. G. W. Mascord, the mechanical superintendent of the Company, we were shown through the large machine rooms and were given an opportunity of inspecting the driving and controlling equipment of the rotary presses, the automatic stereotype plate casting machinery, the labour-saving devices for feeding the heavy rolls of paper into the machines, and the many useful electrical contrivances (several of which have been specially designed by the engineering department) which contribute to the rapid production of a number of daily and weekly papers.

Electric Fans and Fuel Saving.*

By CHARLES CATLETT.

The statement that by agitating the air in a room an economy in fuel can be made is not strictly true. The use of an electric fan in winter may, by making more available the heat in a room, nevertheless reduce the total amount of heat which by the ordinary methods of heating must be added.

A moderate-sized room, which at the time was overheated by a low-pressure radiator, was tested with an accurate chemical thermometer, and the air was found to be in more or less distinct layers, with a very marked difference in temperature between floor and ceiling:—

Distance above floor, in.	Temperature, deg. Fahr.	Distance above floor, in.	Temperature, deg. Fahr.
124	83	44	74
108	80	31	68
92	80	4	66
64	76	0	62

The total amount of heat in the room was sufficient to make the whole room approximately 74 deg. [illegible]

[illegible]

[illegible] diagonally toward the ceiling the temperature near the ceiling was [illegible]

[illegible]

[illegible]

* [illegible]

The Electrician.
FRIDAY, MARCH 22nd, 1918.
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The Education Question.

Last week the Education Bill, introduced by Dr. H. A. L. Fisher, President of the Board of Education, was read a second time. It will be remembered that a similar Bill was introduced last year, but was withdrawn owing to the difficulties which were raised, more particularly in regard to administration. The present Bill has been modified so as to remove these objections.

Any measure of this kind which introduces sweeping changes is certain to be met with considerable opposition. We can quite imagine the difficulties that must have been suggested when the present compulsory age of 14 was fixed; and the variation of this age to a higher one will certainly give rise to misgivings in the minds of many people. It does not follow, however, that these misgivings are well founded. In affairs of Government, and even in affairs of business, there is always a party which prefers to keep matters *in statu quo* rather than introduce changes which may be considerably more satisfactory, but which, of necessity, remain to be proved. Such people argue largely on the basis that "bad you know is better than bad you don't know," but progress on these lines is impossible.

The debate last week makes interesting reading, both from the point of view of the Government and of those opposing the Bill. We have first of all the general principle which was well laid down by Dr. FISHER. This principle is that we should deal with what must be regarded as an inherent defect in our present system of education, namely, that the vast majority of the young people in this country go out into the world after the period of elementary school has passed and are thereafter subject to no sort of disinterested supervision whatever, so that we have a continual wastage of ability, of character, and of physique. We think it will be admitted by any fair minded person that to put boys of 14 to earn their living, to work daily through the recognised hours of adult labour and to be under no kind of supervision beyond that of the foreman, is only harmful. A great degree of liberty is suddenly assumed by the boy on leaving school, there is no inducement to retain knowledge which so far has been imparted to him, and, generally speaking, no one is responsible for his physical development. Such a plan as this is certainly not well calculated to fashion character. That this is generally regarded as a bad system is evident from the fact that no well-to-do parents will adopt it. On the contrary, such parents make the heaviest sacrifices to save their children from premature exposure to the risks of industrial life.

Under present conditions this industrial life is by no means limited to children of 14 years and above. Half-time is allowed in many cases, which accounts for the statement that in Lancashire and Yorkshire a large proportion of children over the age of 12 or 13 are working half-time in the mills. This is not only bad for the children concerned, but it is also bad for those who are undergoing whole-time education, because the two classes cannot well be separated. We think that Dr. Fisher is right in arguing that if there is any one single reform which educationalists would desire it is the further limitation of the hours of industrial toil during the elementary school life.

The opposition to the Bill comes mainly from those who consider that such changes will be bad for our industries. The effect of the change may be regarded as partly immediate and partly prospective. We think it will be agreed that the prospective effect must be all to the good, for the simple reason that our industries will gain in the long run if those who are engaged in them are more educated. With regard to the immediate effect, this is a question whether the curtailment of the supply of juvenile labour would place certain industries in difficulties. We fear that the advancement of this plea means that certain industries attempt to exploit the youth of this country and that if they could obtain children of a still younger age, they would feel it an advantage. One Member of Parliament made the statement in the debate that in Lancashire a boy or girl between the ages under discussion was capable of running three or four looms, and for all practical purposes might be classed as a fully skilled adult worker. If that is so it means that advantage is being taken of youth to obtain cheap labour; it is certainly not a sound argument for opposing the raising of the age limit. If this is the only kind of argument that can be adduced and if the raising of the age limit is for the good of the country as a whole, then those who are responsible for our industries should not oppose the change any more than they would feel justified in opposing the various regulations of the Factory Acts.

The only alternative so far suggested appears to be one of selection rather than of education of the children as a whole. At the age of 14 selection is by no means an easy matter, as it is difficult to say how children are developing at that early age. It would be more reasonable to give further education for another two years and then to make a selection. We do not suggest that the step is free from difficulties; but that is not a valid reason for shelving the whole measure. Difficulties will almost certainly arise in details, and the smoothness of working will inevitably depend very largely upon the common sense with which these details are arranged. Also, the effectiveness from the national point of view will depend very much upon the character of the education that is given, and its suitability to the life's work which is to follow. It would be absurd, for example, to suppose that the teaching of French and the piano would be an advantage in these years of additional education. On the other hand, there is a vast deal of knowledge that might be imparted and which would be of lasting value. Whether this should be imparted on four days a week during two hours per day, or whether half-time should be adopted is a question for consideration, but the main thing is that it should be imparted during some portion of the regular working day. In the case of boys going into definite trades there would be an obvious advantage in the instruction being given in a continuation school of a technical kind. A scheme of this kind has been elaborated by the North-East Coast Institution of Engineers and Shipbuilders. But in any case it will probably be felt that merely eight hours per week is all too short. Considering that the day's work must inevitably be interrupted, we think it is a question whether half-time on four days a week would not be a more satisfactory arrangement, and would possibly cause somewhat less dislocation in the work.

In subsequent debates we hope that those responsible for the industries of this country will consider the measure from the broadest point of view, having regard to the ultimate advantages, and will not raise opposition of a short sighted character, such as to negative the centre principle of the Bill, namely, the application of part-time schooling on bold lines.

The Mechanical Design and Specification of the Turbo-Alternator Rotor.*

By S. F. BARCLAY, Ph.D., B.Sc.

Summary.—The section deals first with the relative merits of the solid and laminated types of rotor, the maximum diameter that is permissible [illegible] of steel. He then passes on to the design of the shaft, the effect of [illegible] stresses, the design of end bells and the provision of adequate ventilation.

Comparison of the Solid and the Laminated Rotor.

There still remains some discussion as to the advantages of the solid as compared with the laminated rotor. From the electrical point of view, for polyphase work there is no essential difference. For a given design, theoretical considerations would indicate that the maximum momentary short-circuit current would be less with the laminated than with the solid rotor. Since, however, the alternator with a solid rotor can quite well be designed to stand short-circuit at the terminals without damage, this property of the laminated rotor is without practical value. On the other hand, the better electrical contact that is established between the slot wedges with the solid rotor causes the rotor to constitute a more effective damping winding, and so gives greater electrical stability. With an unbalanced load there is less heating with a laminated than with a solid core; but, again, this quality is usually of no advantage. In a normal turbo-alternator the output is limited by the rotor heating, and it is obviously a great advantage of the solid rotor that the ventilating channels can be arranged to secure the best cooling effect, whereas with the laminated rotor they have to be provided where mechanical considerations permit. The essential weakness of the laminated rotor is the presence of the central hole through which the shaft passes. On account of the thickness of the metal between the bottom of the slot and the inner bore being comparable in magnitude with the diameter of the bore, the maximum stress exceeds considerably the average stress, and the design becomes limited by the stress at the inner periphery. The weakness could be avoided if instead of cutting the keyway in the disc a projecting tongue could be formed to register in a keyway in the rotor shaft. Such an arrangement is not practicable, because the tongue would prevent the inner bore of the core being machined. To give the essential good fit of the core on the shaft, the core should be bolted solidly together between stout end plates and be bored to a smooth surface, and the shaft then be ground to suit with the necessary shrinkage allowance. Apart from being desirable to ensure a good fit, it is vitally important to bore out the core in order to remove the metal that is strained and weakened by the punch.

The solid rotor has the great advantage that the bursting stress is always less than the stress in the tooth, and the former stress has, therefore, never to be considered. Another matter to receive consideration when discussing the laminated rotor is the question of the material available for the core discs. Such material is prepared by rolling down hot slabs into sheets of the thickness required. The structure of the steel is influenced very considerably by the finishing temperature of rolling and by the rate of cooling. With a large thin sheet it is impracticable to maintain a uniform temperature throughout, and a micro-examination after rolling shows appreciable variations in the crystalline structure at different parts of the sheet. Since material of this kind is inherently less dependable than a high-class forging, the factor of safety should be higher than with the solid rotor; but, due to the weakening effect of the central hole, the designer has to be content with a lower factor of safety.

To meet the demands of the electrical engineer for steel sheets having a high tensile strength, some manufacturers have taken advantage of the additional strength given by cold working. In the original Paper the author shows that there are reasons which prevent this method from being effective.

In place of cold working, another method of producing plates of high tensile strength is to employ a high carbon content. The ductility of such steel, however, is not good, and it cannot be regarded as being suitable for the duty.

Another point to receive consideration with the laminated rotor is the question of the critical speed. Practically always the running speed is above the first critical speed, and with large outputs at 3,000 revs. per min. the running speed may be above the second critical speed. If the laminations were fairly loose in the axial direction the critical speed of the shaft could be accurately determined. With a newly constructed rotor the critical speed may have a satisfactory value, but after some running there may be a lowering of the critical speed and severe vibration may result.

For large-diameter rotors at medium speeds thick plates are sometimes employed instead of laminations. This construction is preferable to using thin sheets, but the weakness of the centre hole and the high hoop stress, together with the unsuitability of using rolled plate with a pronounced fibre subjected to high stress in all directions, are still present, and when the critical speed is below the running speed trouble with it is equally if not more pronounced.

Another alternative is the construction of using plates of considerable thickness held together with through bolts with a short shaft length at either end and no central hole. The great weakness of this construction is the difficulty of making the bolts satisfactory. The deflection is due almost entirely to the elongation of the bolts, the area of the plates being large compared with the area of the bolts, and the compression of the plates therefore negligible. A very slight elongation of the bolts takes all compression off the plates, and consequently at the underside of the rotor the plates are out of contact. Each time the rotor turns round, stress in addition to the initial stress is thrown on the bolts. Another disadvantage of the plate construction is apparent when the critical speed is considered. Since the bolt area in tension is small compared with the rotor weight, the deflection in the body of the core is considerable, and hence the critical speed is very low. It is almost impossible to avoid some degree of synchronism of the normal speed with the harmonics of the natural period of transverse vibration. The effect of the plates meeting, by the great area of compression they offer, prevents any appreciable swing of the rotor beyond the neutral axis. Vibration is thus damped, and such a rotor has no real critical speed, but there may be sufficient vibration to be appreciable.

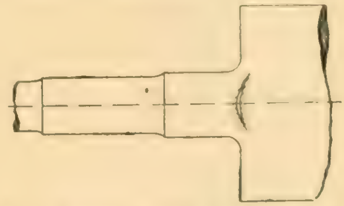

Fig. 1.—Forging Defect in High-speed Rotor.

Such a construction can be seriously considered only with relatively large and relatively low-speed rotors, and is only to be employed when forgings are unobtainable.

The Maximum Desirable Diameter of the Solid Forged Rotor.

The forged rotor, having no central hole, is very much stronger in its resistance to bursting than is the laminated rotor. It can be shown mathematically that a minutely small hole through the centre of a rotating cylinder doubles the stress. The maximum stress with the solid forged rotor is always in the teeth, but the stress never reaches a high value, the maximum rotor diameter being determined by other considerations.

With the type of winding now in universal use, of concentric coils of flat copper strip there is a fairly definite limit to the rotor diameter that may be employed for a given speed. There are to be considered the stability of the end windings relative to the core, the pressure on the insulation between turns and the retention of the end windings against the action of centrifugal force. In the case of a 5,000 kw. alternator at 3,000 revs. per min. with a 31 in. diameter rotor, when running at the overspeed of 20 per cent. above normal, the average value of the maximum pressure on the insulation is about 5,000 lb. per square inch. The requirements of the insulation between turns are good electrical properties, capacity to stand high temperature without deterioration, and mechanical strength. The [illegible] strength of [illegible] is the only material that is really suitable for the purpose.

The stability of the coils is greatly improved as the breadth of the strip is increased. The practice of some manufacturers is to employ either a large number of coils with a [illegible] section of copper, or seven coils per pole [illegible]. A far better arrangement is to use fewer coils of greater copper breadth.

* Abstract of a Paper read before the Institution of Electrical Engineers.

Under steady compression between flat surfaces mica can stand great loading before failing. In service, however, it is to be remembered that the conditions are not nearly so ideal. There is always some degree of high-frequency vibration present, and the surface of the copper is never quite flat. For these reasons a big margin of [illegible] necessary.

Whereas the limitations due to end coil stability and insulation pressure are indefinite, as will be seen later, the limitation due to the difficulty of retaining the rotor end-windings is quite definite. Having regard to these circumstances, the author believes that for a normal speed of 3,000 revs. per min. a 32 in. diameter rotor will come to be regarded, if not as the maximum permissible size, at least as the maximum desirable size.

THE CHOICE OF ROTOR STEEL.

The obvious requirements of the rotor steel are that the permeability should be as high as possible, and that mechanically the material should be suitable for the duty. Beyond doubt, the steel that best fulfils these requirements is an oil-treated carbon steel. Such a steel, containing about 0·38 per cent. carbon, after oil treatment has an ultimate strength of 38 tons per square inch, a yield point of 22 tons, an elongation of 22 per cent. on 2 in., and a contraction of area of 40 per cent. It is of the class of steel that is used for such purposes as railway axles, and has to resist shock and fatigue and be dependable above everything, and is therefore admirably suitable for alternator rotors. The permeability of this steel is quite good.

It is usual to express the factor of safety in terms of the ultimate strength—which is not quite logical, since it is the yield of the material that marks the limit of safety and not the actual fracture. The author is of the opinion that the factor of safety should always be expressed in terms of the yield point. The maximum stress in the solid forged rotor is in the teeth. The stress is unidirectional and constant, and a factor of safety of 2 to 1 on the yield point is to be regarded as satisfactory with a dependable steel.

It is sometimes suggested to employ an alloy steel for the rotor, but there is very little gain, if any, in doing so with the objects immediately in view, and on the other hand there are pronounced disadvantages. The permeability is lower and the forging is not so reliable. An interesting case came to the author's notice a few years [illegible] where the shaft merges into the body of the core. [illegible] care in forging might cause weakness in this [illegible] probable with an alloy steel than with a carbon steel.

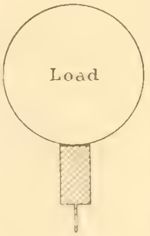

FIG. 2.—SHOWING HOW A BEAM CAN BE WEAKENED BY ADDING TO ITS SECTION.

[illegible]

For all outputs so far contemplated at 3,600, 3,000 and 2,400 revs. [illegible] and also for all except very [illegible] per min. For very large [illegible] a single forging may not be satisfactory. In such cases the soundest construction is to [illegible] attached to each end, [illegible] Forging the cylinder on [illegible] qualities on the [illegible] Moreover, [illegible]

[illegible]

therefore, not only must the area of the steel be adequate for the load to be carried, but the proportions must be such that it is free to yield elasticity to exert its reactive force without any local over-stress being caused. If the design is such that there is a tendency for some part of relatively small area to resist the general deflection, that part may be overstressed and failure may result. An example of such a case is given in Fig. 2. The beam with the fin projection and the load can be so proportioned that before the beam has deflected sufficiently to give the necessary reaction to support the load crystals at the bottom of the rib are overstressed. Failure, therefore, would result with such a construction, whereas the beam without the fin would carry the same load satisfactorily. Where there is an abrupt increase of diameter in a shaft the conditions are somewhat but not exactly similar. Just where the increase of diameter takes place the shaft portion is under stress, and is yielding elastically. The flow of stress into the larger diameter is somewhat gradual, and the face of the metal that is rising at right angles from the smaller diameter to the larger diameter carries little or no stress, and there is, therefore an intimate contact steel that is elongating and compressing elastically and steel without stress, and great weakness is thus caused.

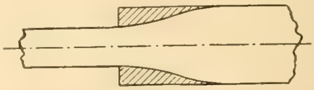

FIG. 3.—A SUDDEN INCREASE IN DIAMETER MAY BE REGARDED AS ADDING METAL TO A GRADUAL INCREASE, AND IS ANALOGOUS TO THE WEAKENING EFFECT OF ADDING A THIN RIB TO A BEAM AS SHOWN IN FIG. 2.

A gradual change of diameter represents a normal design, and a sudden change is to be regarded as adding metal to the normal design, as shown shaded in Fig. 3. The added metal tends to prevent the normal elastic deformation, and has inadequate strength for the purpose. In such a case the tendency to fail is often increased by the crystals at the junction of the two diameters being torn and weakened by the action of the cutting tool.

In Fig. 4 is shown a case of failure that came to the author's notice a few years ago. It will be noticed that there is a very sudden increase of diameter between the bearing journal and the large oil baffle that is formed solid with the shaft. After 11 months' running the shaft broke in the position shown. Not only was the design thus most unsound, but the material was unsuitable, being of a high carbon steel that had not been heat treated and having a very coarse grain size.

Abrupt changes in the curve of deflection must therefore be carefully avoided. The shaft should be gradually stepped to avoid any sudden increase of diameter, and wherever a change of section occurs a carefully formed radius should be provided. Gauges to check the accuracy of the radii in important places, such as in the neck of the journals, should form part of every shop inspector's equipment. In addition to being carefully formed, the radii should be given a fine finish and good polish.

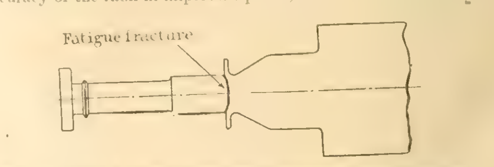

FIG. 4.—SOLID FORGED ROTOR WITH DEFECTIVE SHAFT DESIGN.

ALTERNATING STRESS.

The maximum reverse stress in the rotor is in the neck of the bearing journal. The weight of the rotor puts the figure at the top of the shaft into compression, and at the bottom of the shaft into tension. As the shaft turns round the stress changes from tension to compression. In the case of a 3,000 revs. per min. alternator the number of reversals per day is 4,320,000, that is to say, the number of reversals daily is equal to what investigators into the subject of alternating stress have regarded as a complete endurance test. The [illegible] takes place in the crystalline [illegible] through fatigue.

[illegible] and so many [illegible] that a big margin [illegible]

[illegible] in the [illegible]

Correspondence.

ELECTRICITY AND SORTING MACHINERY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Under the heading of Transport Reform we daily read of proposals for the more effective collection and distribution of all classes of merchandise, and it is not hard to see that, though internal combustion traction will probably play an important part in what may be called mid-distance traffic for many years t, c me, electricity will be the ultimate motive power of all the sorting machinery of the future. We see the principle applied already in the outskirts of big towns, and the day is not far distant when the suburban passenger traffic of all big cities will be electrified. After all, what is the electric train system, which is now so effective, punctual and rapid on the suburban district of the London & South Western Railway, but a big passenger sorting machine? It is a machine which is of great value to business men and saves thousands of man-hours every week.

The pre-war inland goods transport rates—double those of any other country in the world—have been responsible for much trouble in the past, for they have acted as a drag on our farmers, manufacturers, and traders, and have made a fair bid to strangle our commerce. The reason for the high rates is to be found in the obsolete and extravagant arrangements at all the great railway termini. To do away with this state of affairs a system, known as the Goods Clearing House System, has been devised by Mr. A. W. Gattie, who, by means of electromagnetic sorting machinery of his own invention, is able to deal with the collection and distribution of heavy goods of all descriptions just as easily as banking clerks are able to deal with the bundles of cheques which daily pass through their hands.

Our railways continue to waste time and space and man power by operations on "flat-land," *i.e.*, pushing trucks and wagons backwards and forwards in goods shunting yards; whilst Mr. Gattie brings to bear electric cranes, and, by thus utilising the third dimension of space, does work in one-hundredth of the space and in less than one-hundredth of the time at present used. The work of sorting is mainly effected by endless bands of truckers electrically controlled; these truckers are always moving, so that congestion is impossible.

It is interesting to note that Mr. C. R. S. Kirkpatrick, M.Inst.C.E., the chief engineer to the Port of London Authority, recently spent a considerable time at the works of the New Transport Co. at Battersea. He was able to make a thorough examination of the electromagnetic sorting machinery which [illegible] the leading feature in the goods clearing house system. This system can be applied to all wharves and quays where the rapid loading and unloading of ships is a desideratum, and it is therefore receiving the attention of various Chambers of Commerce in the Kingdom. In his report on the Gattie system, Sir John Purser Griffith, late engineer of the Dublin Port and Docks, writes very favourably, and indeed all the [illegible] eminent engineers and men of science have given it their unqualified approval.

In June, 1914, two months before the war broke out, a German scientist, Herr von Schwer, was [illegible] by the Kaiser to examine the machinery at Battersea. He did so, and was so much impressed with what he saw and learned that he exclaimed in terms of [illegible] admiration, "What an unequalled [illegible] for mobilisation!" A report now reaches us that this system has actually been adopted in Germany, and, if the report is true, we shall have before us another telling example of what the enemy can do in the "too late" line. It is well to point out that the system of which we are writing has been before the authorities in this country for the past eight or nine years, and that the said authorities have persistently refused to even inquire into its merits during the whole of that time!

It may thus be [illegible] to our [illegible] to [illegible] the [illegible] of an Englishman's inventive [illegible]. Does such a state of affairs indicate patriotic forethought on our part, or does it point to an overstraining of chivalry which has induced us to offer our most deadly foe the first use of our best weapon against congestion and waste of time? Anyhow, by ignoring the system ourselves we have given our rivals every possible opportunity of being first in the field and exploiting it to their own advantage.—I am, &c.,

London, March 14. Headley.

Annual Meeting of the B.E.A.M.A.

The Annual General Meeting took place on the 28th ult., when the report and income and expenditure account and balance sheet for the financial year ending Sept. 30, 1917, were adopted; and the following members were declared on ballot to have been elected to fill the five vacancies on the Council:—

British Electric Transformer Co., [illegible], [illegible] & Co., Mather & Platt, C. A. Parsons & Co. and Yates & Thom.

The chairman, before moving the adoption of the report for 1918, referred to the report of the Committee appointed by the Board of Trade to consider the question of the electrical trades after the war. The report had not yet been published; but he did not think he would be committing any breach of confidence in stating that he believed the report was a very strong one, and that it would be received with gratification by the industry, particularly as it was understood to speak largely along the lines of the B.E.A.M.A. evidence.

Turning to B.E.A.M.A. work during the past session, he said two important reports in which the industry was interested had made their appearance. The first was that of Lord Buckmaster's Committee on pre-war contracts, which, he regretted to say, appeared to afford little direct practical help to contractors, but, in traversing old ground, offered some new suggestions of which, failing Government action, they might be able to avail themselves. The second was the [illegible] sub-Committee's report. That deserved their careful attention, and would, he hoped, shortly be the subject of action by the B.E.A.M.A. As to B.E.A.M.A. conditions of contract, it was satisfactory to record that less difficulty in settling contracts was experienced and these conditions were making steady headway. The subjects of research and education were in the B.E.A.M.A. front line of action, and standardisation had made satisfactory progress during the year. They were in close touch with the work of the Federation of British Industries and the British Empire Producers' Organisation, and it went without saying that they were working jointly in many matters with their old friends the E.S.C., the I.E.E. and the C.M.A. The [illegible] had been [illegible], and the B.E.A.M.A. was now an Association for manufacturers exclusively, the classes of "Associate Member" and "Associate," consisting chiefly of factors, having been cut out.

We hope to give an abstract of the report in our next issue.

Legal Intelligence.

Marconi Imperial Wireless Chain Litigation.

[illegible] stations.

Counsel for the Company were Sir Edward Carson, K.C., M.P., Mr. [illegible]

[illegible]

the construction of the six stations, and of their intention to arrange for engineers and staff to proceed in connection with the work. The Company said that no notice was at any time given by the Postmaster-General of his cancellation of such part of the agreement as related to the installation of the stations in the Union of South Africa, India or Singapore. On the contrary, the Company said that in the case of the Indian station, the Postmaster-General decided, on or about May, 1914, that such station should be proceeded with in the first instance, and so informed the suppliants who agreed to proceed with the service. The Company had at all times been ready and willing to proceed to carry out the installations between August, 1913, and December, 1914. On Dec. 31, 1914, a letter from the Secretary to the Post Office repudiated the agreement and refused to allow the Company to proceed further with the installations or any of them. Having read this letter counsel said there was a question as to what was its effect, but he did not think there was any question or intention to put an end to the whole contract.

Sir F. E. SMITH: A grave question will arise whether long before the date referred to the contract had not been in express terms ended by the Company themselves.

Sir E. CARSON said that on Aug. 21 the Postmaster-General paid £62,000 on account of expenditure incurred. There were other sums which he need not mention. The Company said that they had been greatly damaged by being deprived of all the royalties which they would have earned under the agreement and that they had lost the whole of the monies expended. The Attorney-General in part of the defence raised stated that the Postmaster-General had never waived or agreed to the extension either wholly or in part of the right of cancellation conferred upon him by Clause 2 of agreement. That, of course, could only be a matter which went to the question of damages. What the Company said was that he had never exercised the right of cancellation. The Company had always admitted that at any time up to the completion the Postmaster-General had the right to cancel upon paying out-of-pocket expenses and costs. The Attorney-General then said "the proposal to proceed with the Indian station in the first instance, was a proposal emanating from the suppliants and made by them to the Postmaster-General by letter dated Nov. 6, 1913. The Postmaster-General subsequently agreed to such proposal, and further proposed in a letter to the suppliants on May 15, 1914, that in consequence of the said arrangement with regard to the Indian station the power of cancellation conferred upon the Postmaster-General by the said agreement should be varied so as to cease to apply to the Indian station and to apply to the East African station in place thereof, but the suppliants never replied to the said proposal or assented to the said variation." The whole of that came to this "right of cancellation in respect of the Indian station as one of the three, and by arrangement the Indian station was to be proceeded with immediately, a proposal by the Company which is not assented to, but as you are doing that you ought to include one of the other stations in its place." All that merely went to damages and had nothing to do with the question as to whether the contract was repudiated. If the Company had judgment on the first Clause, one of the questions that would have to be considered would be what loss was to [illegible] that the Company were not allowed to construct the three stations in respect of each of which the Postmaster-General had up to the time of completion the right of cancellation. In another paragraph of the defence it was set out that by letter dated Dec. 30, 1914, the Postmaster-General informed suppliants of his intention not to proceed with the said wireless stations, and the Attorney-General submits that the Postmaster-General thereby exercises the right of cancellation conferred upon him by the said agreement in respect to [illegible] the right of cancellation lays. Then the Attorney-General said: "The suppliants having lost the benefit of the agreement of [illegible] of the repudiation thereof on the part of the [illegible] Postmaster-General and that the letter of [illegible] 1914, from the suppliants, [illegible] the said agreement as abandoned. [illegible] there had been no abandonment [illegible] upon the part of the Postmaster-General." [illegible] between July, 1913, and August, 1914, [illegible] made by the Post [illegible] was asserted [illegible] of the Post Office [illegible] the contract. Negotiations [illegible] that the Post [illegible] and to get the [illegible] In the course of the correspondence it was said over and over again that the delays showed [illegible]

an assurance that at least the amount already expended by the Company on the stations would be repaid at an early date, and also asked what steps it was prepared to take to arrive at the sum to be paid to the Company as compensation for the abandonment of the contract. In the reply (dated Jan. 21, 1915) the Postmaster-General said that the situation created by the war had made further provision for wireless telegraphy in its military aspects of much greater national urgency and importance than its immediate commercial development, and the Admiralty accordingly was negotiating for further stations to be constructed by the Company with the least possible delay. The new scheme was directed to meet urgent military necessities, but it might also provide an opportunity for later development in which the problems of commercial as well as of military service should be reconsidered as a whole in the light of the experience of war. The Postmaster-General had anticipated in view of what he believed to be the past attitude of the Company that they would not unwillingly acquiesce in the dropping of the contract of 1913, especially in view of the Government contract being negotiated with the Admiralty. The Postmaster-General found it difficult to understand on what ground the Company should regard the desire not to carry out further the contract as a reason for claiming substantial damages over and above an indemnity which would, of course, be quite proper in respect of the work already done under it. But since the Company took up that position, the Postmaster-General, on behalf of the Government, withdrew his letter of Dec. 30, and noted that the Company regarded the contract as binding upon both sides in its entirety, and was prepared to co-operate in carrying out its terms with all possible promptitude. That letter was an unreasonable offer under the circumstances, and one which they were not bound to accept. A great many of the delays and difficulties which had arisen were due to an atmosphere of fear that was created in the House of Commons and from attempts made from time to time to procure other people to come in and act in a competitive manner as against the Company.

Sir EDWARD CARSON proceeded to read correspondence between the parties, &c. He said that in June, 1914, Mr. Godfrey Isaacs was in Paris and learnt that the Postmaster-General and Sir Henry Norman were in Berlin and had invited the Telefunken Co. to start in England in competition with the Marconi Co. Mr. Isaacs eventually obtained a signed statement from two directors of the Telefunken Co. He read a translation of a letter which Mr. Godfrey Isaacs had recevied from Berlin on July 21, 1914. That letter read:—

"Re Lepel. As I told you upon the occasion of our meeting in Paris, when the Postmaster-General and Sir Henry Norman were in Berlin they made an offer to the Telefunken that they should start in keen competition in England with the Wireless Co. and that we could rely upon the Government's support provided that the Telefunken would make offers lower than the Wireless. Having regard to the arrangements which we have made, we told these gentlemen, that we are naturally competing with the Wireless in England and that it would be practically impossible for us to make lower offers than the Wireless Co., having regard to the fact that our expenses on account of licences, &c., would be higher than those of the Wireless Co., besides which our patent position in England was uncertain. From this Sir Henry Norman formed the opinion that there would be little question of relying upon the Telefunken Co. as a competitor of the Wireless in England, and he therefore approached Herr von Lepel with the object of encouraging him to form an English company and to obtain for him financial assistance. With this object, amongst others, we understand that these gentlemen are endeavouring to obtain financial support from Mr. Beit. We did not want to fail in giving you this information, and remain yours faithfully, GESELLSCHAFT FUR DRAHTLOSE TELEGRAPHIE m.b. H.— BREDOW. SOLFF. P.S. Mr. Hird knows more."

The ATTORNEY-GENERAL said that Mr. Charles Hobhouse denied the statements contained in that letter.

Sir EDWARD CARSON said that Mr. Godfrey Isaacs saw Mr. Murray and told him that he regarded it as a very serious matter. Mr. Isaacs afterwards had an interview with the Postmaster-General at his request. The Postmaster-General at that interview admitted that he had gone to Berlin and that he had regard to the contract then existing between the Marconi Co. and the Government. In a letter written by Mr. Joseph A. Pease to Mr. Isaacs on June 28, 1916, it was stated that Mr. Hobhouse had informed Lord Reading that there was no foundation of any kind for the statements alleged to be contained in the Telefunken letter, and if such statements were made he would take proceedings to prove that they were without foundation. Both Mr. Hobhouse and Sir Henry Norman absolutely denied that anything of the kind read out by Mr. Isaacs to Mr. Pease occurred, and they were much incensed that there should exist any such libellous statements in any letter. In reply to Mr. Pease's letter Mr. Isaacs stated that on Nov. 6, 1914, he gave to Mr. Murray (at an interview with him at the Post Office on that date) the contents of the letter in question as one of the principal reasons why he mistrusted the Post Office, and he informed him that he would report their interview to the Postmaster-General, who in turn would have to put the matter before the Cabinet. Early in 1915 Mr. Hobhouse approached his brother (Lord Reading) with a view to obtaining a private interview with Mr. Isaacs. At two interviews he (Mr. Hobhouse) admitted that he did make the offer in question to the Telefunken, but said he did so because he thought that competition would be a very good thing for the country. There was only one point at issue when he saw Mr. Hobhouse on the above occasions, and that was as to whether he had been once or twice to Berlin. I was under the impression that he had been there twice. He assured me that he had only been once. After his interviews with Mr. Hobhouse he reported what had taken place to his brother (Lord Reading). Mr. Marconi and some of his directors

and others in the employ of the Marconi Co. He had never had any conversation upon the subject with Sir Henry Norman.

During the course of Sir Edward Carson's opening statement on Monday, the ATTORNEY-GENERAL **intervened and said that the matter had been a long standing subject of negotiation, but the Solicitor-General and he had taken the view that it was extremely difficult for the Government** to contend that there had not been a breach of the contract, for which the Government was responsible. Discussions had taken place between the parties about the proper basis on which damages should be assessed. Questions of great difficulty and complexity arose. It appeared to him and those who were with him that it was a disputable question where the balance of the responsibility lay for the admitted delays which took place. Then there was the question, What was the effect in law which ought properly to be given to the letter of Jan. 21, 1915? And there was the further question, What number of stations ought to be accepted as the basis of compensation, upon the assumption that the contract had, in fact, been broken? He had formed the view that it was desirable that the discussion should take place in public, so that all that was said, and all that was done, should be appreciated by those who had followed the matter in the past. It would not be proper that the person who would assess the damages should have his discretion fettered by the letter of Jan. 21, 1915. [illegible] damages ought, therefore, to be dealt with as if the letter of Jan. 21, 1915, had not been written. He had also formed the view that the basis of compensation should be [illegible] was that the cancellation was unlimited in its terms and could not be contended for. He could not resist the contention that it was intended that the option with reference to the three other stations would only be [illegible] making invention which was so obviously better than the existing apparatus that the Government would be compelled to scrap the existing apparatus. No such case had arisen. Therefore the declaration would [illegible] convenient that the name of the person should be left in blank. It might [illegible]

[illegible] Crown was the right one. The case was one of great difficulty and had [illegible] very full and lucid statement made by Sir Edward Carson in opening the case certain important points emerged, in his view, in favour of the [illegible] of July 30, 1913, [illegible] some expert to be appointed.

British Thomson-Houston Co. (Ltd.) v. Duram (Ltd.)

On Monday, the House of Lords [illegible]

[illegible]

all purposes, and in view of the general claim originally made (claim 5) and its subsequent abandonment, one would expect clear words if it was intended to put forward any claim of that kind. In his opinion the words "in a coherent form" could not be read as denoting tungsten obtained by appellants' preparatory process or its equivalent. It was upon that first point that appellants chiefly relied, as showing subject-matter. In his opinion it failed, and the first claim was, on its true construction, one for subjecting any form of the coherent metal to the influence of heat while it was being operated on or manipulated. Appellants, however, further asserted that the application of heat, especially (as they put it) of continuous heat during the process of working, showed invention and was good subject-matter. There could be no subject-matter in the application to tungsten of the old process of working under heat. Appellants asserted that they discovered that tungsten was peculiarly sensible to any lowering of temperature, and they pointed out that it was preferable to heat both rolls and tungsten while the rolling operation was going on. But there were no special directions for the application of heat to tungsten for that purpose. The claim was merely for subjecting the metal to the action of heat while it was being worked and the operator was left to find out by experience what were the necessary precautions. Mr. Justice Astbury and the Court of Appeal were of the opinion that the action was not maintainable, and after a very full argument he had arrived at the same conclusion. Accordingly he moved that the appeal should be dismissed.

LORD DUNEDIN, in differing from the opinion expressed by the Lord Chancellor, said that the first inquiry must always be whether the patentee had made any discovery. The method of conducting such inquiry was first to inform one's mind by evidence led as to the common knowledge possessed by those conversant with the trade or art at the time of the alleged discovery. Then reading the specification as a whole, one could proceed to determine whether it disclosed something which common knowledge, coupled with the ordinary application of such knowledge, would not have made available. His Lordship then referred to the evidence given as to what was the state of common knowledge when the patent was applied for and said that he found no difficulty in [illegible] knowledge to indicate any way of drawing tungsten wire to form filaments for electric lamps, the reason being that tungsten in any form as [illegible] for that purpose. The claim was not, as he read it, a claim for the [illegible] for the selection of pure coherent tungsten and the applic[illegible] of his ingenuity. For these reasons he thought that the appeal should have succeeded.

[illegible] Chancellor that the appeal should be dismissed.

[illegible]

Patent Record.

SPECIFICATIONS PUBLISHED.

[illegible]

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is a fixed.*

February 4, 1918.

[illegible]

2,030 Vickers (Ltd.), Field & Heap. Electric contacting devices.
2,031 Vickers (Ltd.), Field & Heap. Electric contact actuating mechanism.
2,032 Vickers (Ltd.), Field & Heap. Electrically controlled devices.
2,047 Neuland. Electric generators.

February 5, 1918.

2,051 Cooper. Electric flash preventing device.
2,072 Monks. Change-over switch for spare transformer.
2,077 Lyon & Wrench & Todman. Electric governing devices.
2,081 W. T. Henley's Telegraph Works Co. & Judge. Fuse boxes.
2,089 B. T.-H. Co. (G.E.Co.) Electrical distribution.
[illegible]

February 6, 1918.

[illegible]

2,116 Barnicoat. X-ray screen for localisation of foreign bodies.
2,120 Harris. Cooling and ventilating motors and dynamos.
2,134 British Insulated & Helsby Cables & Wilson. Fuse carriers or connecting devices.
2,146 Reyrolle & Co.,& Beard & Collins. Protection of windings of electric generators, &c.
2,153 Western Electric Co., Deakin & Polinkowsky. (Western Electric Co. & Stevens, partly.) Machine switching telephone systems.
2,164 Kelso. Controllers for electric motors.

February 7, 1918.

[illegible]

2,235 B.T.-H. Co. (G.E. Co.) Electro-magnetic switches.
2,264 Sperry. Searchlights. (7.2.17, U.S.)
2,265 Vickers (Ltd.), Matthews & Pearson. Electric heating systems.

February 8, 1918.

2,293 Hackett. Microphones.
2,309 B.T.-H. Co. (Newton.) Elastic fluid turbines.
2,310 B.T.-H. Co. (G.E. Co.) Elastic fluid turbines.
2,311 Lappin. Cleat for supporting cables.
[illegible]

February 9, 1918.

2,348 Efandem Co. & Williams. Switch apparatus for electric hand lamps, &c.
2,349 Efandem Co. & Williams. Electric hand lamps carried by projecting handle.
2,368 B.T.-H. Co. (G.E. Co.) Electric furnaces.
2,380 Selsdon Aero & Engineering Co. Sleeve inductors for ignition magnetos.
2,384 Fery. Electric cells.

February 11, 1918.

2,394 Sanders. Electric apparatus for heating liquids.
2,415 Downton. Protection of distribution systems having shunt wires.

February 12, 1918.

2,484 [illegible]
2,494 Uchida. Electric current controllers.
2,526 [illegible] wires.
[illegible] Allgemeine Elek. Ges. Device for suppressing earth currents in high-voltage systems. (23.1.17, Germany.)

February 13, 1918.

2,549 Duffy. Centrifugal type of mercury cut out for dynamo electric machines.
2,5[illegible]
2,572 [illegible]-current motors.
[illegible]
2,602 B.T.-H. [illegible]
2,603 B.T.-H. [illegible]

Volunteer Notices.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Oxford-street, W. 1.

[illegible] Lieut.-Colonel C. B. Clay, V.D.

[illegible]

Commercial Topics.

Overseas Trade Department.

Bills for conferring further powers upon this new Department and for the appointment of a paid secretary, &c., were read a second time in the House of Commons on the 14th inst.

* * * *

Commercial Attaches.

Sir A. Steel Maitland announces that commercial attaches are to be appointed to the following countries :—

Argentine, Belgium, Brazil, Chili, and Bolivia; China (also Shanghai and Hong Kong), Scandinavia, France, Italy, Japan, the Netherlands, Russia, Spain, and Portugal, Switzerland, and the United States.

In all 27 attachés are to be appointed, the total annual cost (including salaries, local allowances and office allowances) being £51,000.

* * * *

Higher Tramway Fares.

In connection with the recent award by the Committee on Production to tramway workers, the following resolution was adopted at a preliminary conference of tramway employers and unions called by the Chief Industrial Commissioner :—

"That Sir Geo. Askwith be asked to obtain from the War Cabinet an undertaking that they will take immediate steps to authorise the increase of the maximum tolls and charges, whether statutory or otherwise, which may be demanded on all tramways or light railways by an amount to be decided by the Board of Trade."

The above resolution was signed by Mr. J. B. Hamilton, representing the Municipal Tramways Association, Mr. R. J. Howley, representing the Tramways and Light Railways Association, and Mr. R. Williams, secretary of the National Transport Workers' Federation.

The President of the Board of Trade will shortly receive a deputation from the tramway authorities of the country in order to ask the Government to consent to a general increase in tramway fares.

* * * *

Patent and Trade Marks Legislation.

On Friday last the President of the Board of Trade (Sir A. Stanley), with the Parliamentary Secretary of the Board (Mr. Wardle, M.P.) and the Comptroller of the Patent Office in attendance, received a deputation representative of the principal Chambers of Commerce, the Federation of British Industries, the Institution of Electrical Engineers, the Chemical Industries, &c., for the purpose of making representations concerning the new Patents and Trade Marks Bills.

Sir Albert Stanley, in reply to the deputation, stated that the Government hoped that it would be appreciated by all the industries that the Bills were in the nature of "war-time" measures, and were designed solely for the protection and the betterment of the industries. On the other hand, abuses had crept in and our enemies had been the most assiduous to take advantage of them. For example, they had endeavoured to build up by the use of trade marks as the names of different products perpetual monopolies that would prevent any person or any trader from being able to supply those products, and thus while if a patent were granted there would be but a limited monopoly for 14 years, when the process would become public property, yet by the astute coining of words to describe a product that which was in effect created was a perpetual monopoly in connection with the product.

In reference to the suggestion that had been made for the introduction of a short bill to extend the life of patents for the period of the war which had been stated to be non-contentious, his experience assured him that sometimes that which appeared a non-contentious bill provoked a great deal of opposition, and he was of opinion that there would be no greater difficulty in carrying through legislation to bring about all the desired reforms in connection with our patent procedure than there would be to carry through a bill dealing with only a portion. All classes of the community suffered, and had to make sacrifices alike of their interests and of their business, during the war, and it would be impossible to place inventors and patentees in a privileged position. Provision had been made in the bill for extending the life of all patents, and also special provisions for extension were proposed when it could be shown that direct losses had resulted due to the war, while a corresponding benefit had been given to the nation in connection with the industries at the expense of the patentee.

As regards the Trade Marks Bill, there were many words that had passed into common language and could be found in our dictionaries as the names of or descriptive of new products, words that were probably coined for the convenience of simple description and designation, and it would be unfair to the manufacturing and trading community to permit a word which had become the only practical designation of devices or products that were now open to all in the realm to produce to be solely associated with the products and manufactures of one firm; for that would be creating monopolies of a perpetual character and hampering and restricting trades.

* * * *

Another Report on Industrial Councils.

The first "Whitley Report" on the relations between employers and employed dealt with industries in which there already exist representative organisations on both sides, but the present report deals with industries in which the degree of organisation is either not so great or nil.

In a prefatory note, Dr. Addison states that its recommendations are

being reviewed by his Ministry and the Ministry of Labour in the light of the practical experience gained in establishing Joint Industrial Councils, and that a statement will shortly be issued detailing any modifications considered expedient. The second report first classifies the industries into three groups corresponding roughly to their degree of organisation:

Group A.—Industries in which organisation is sufficiently developed to render the existing associations of employers or employed, representatives of the great majority of those engaged in the industry.

Group B.—Industries in which, as regards either employers or employed, or both, the degree of organisation, though considerable, is less marked than in Group A.

Group C.—Industries in which organisation, either as regards employers or employed, or both, is so imperfect that no existing associations can be said adequately to represent those engaged in the industry.

The second report recommends for industries in Group B much the same proposals as were advocated in the First Report for Group A industries, with this addition: that, wherever in these industries a National Industrial Council is formed, there should be appointed one, or at most two, official representatives to assist in the formation and to act later in an advisory capacity, to serve as a link with the Government. It may be that some industries coming within Group B cannot, owing to their geographical distribution or other causes, be brought readily within the scope of the proposals for National Industrial Councils, though they may quite well be organised in separate districts. In such a case the Committee recommend the formation of a District Industrial Council, anticipating that its influence will be such that in time the industry will become suitable for the establishment of a National Industrial Council. They also urge the importance of [illegible] councils of women workers.

To industries in Group C the Committee suggest that the machinery of the Trade Boards Act might well be applied, pending the further development of their organisation. The Trade Boards, though originally intended only to secure the establishment of a minimum wage in certain unorganised industries, should [illegible] the regular machinery for negotiation between employers and employed, and should have power to initiate inquiries on all matters affecting their industry.

The Committee also recommend that industries in Groups A and B which have sections or areas wherein the degree of organisation falls much below what is normal in the remainder of the industry, should have some means whereby they may bring the whole of the trade up to a minimum standard of organisation [illegible] of the industry.

* * * *

Workshop Committees.

The Committee on "Relations between Employers and Employed" of the Ministry of Reconstruction has presented a supplementary report on "Works Committees" (or committees of employers and employed in each factory or workshop), the formation of which was advocated in the first Whitley Report.

The supplementary report, which is issued by Dr. Addison, Minister of Reconstruction, states that in every industry there are certain questions, such as rates of wages and hours of work, which should be settled by district or national agreement. [illegible]

Electricity Supply.

Extensions.

Belfast.—[illegible]

Dick, Kerr Turbine Contract for Glasgow.—[illegible] condensing plant and step-up transformers, designed for a continuous output of 18,750 kw.

The turbine will be a single unit standard Dick, Kerr impulse type machine, arranged to run at 1,500 revs. per min., and will operate on steam at 250 lb. per sq. in. pressure at the stop valve, superheated to 650°F., and exhaust into a vacuum of 29·1 in. All overloads will be dealt with by automatic governor valves without recourse to hand operation or by-pass valves, high pressures and temperatures being confined to the cast-steel governor valves and inlet castings. The turbine will be direct coupled to a 6,500 volt 25 cycle three-phase Dick, Kerr alternator, having a maximum continuous rating of 24,000 k.v.a. at 80 per cent. power factor. The machine will be of the self-ventilating type, provided with fans on the rotor drawing the cooling air through a wet air filter of the Heenan & Froude type. An exciter of the overhung type will be provided. The alternator will be electrically connected to a bank of three Westinghouse single-phase oil-circulated water-cooled transformers, stepping up the pressure from 6,500 to 20,000 volts. In connection with these transformers a separate oil cooler and motor-driven oil circulating pumps will be provided. The turbine will exhaust into a standard Willans & Robinson condenser, having a surface of 26,000 sq. ft. The air extraction plant, in duplicate, will be of the well-known Willans rotary water jet system, which possesses the merit of great simplicity and ease in operation, combined with great evacuation power. The vacuum will be 29·1 in. with a 30 in. bar. The extraction pumps, also in duplicate, will be of the usual centrifugal type.

London County Council.—On Tuesday a supplementary estimate of £5,180 for the construction of foundations and [illegible] turbo-alternator at Greenwich power station, [illegible] switchboard gallery, &c., was approved.

A special temporary allowance of £50 a year each for the year ending Dec. 31, 1918, has been made to the following officers of the electrical branch of the tramways department: Messrs. H. Underwood, J. J. McGregor, A. W. Johnson and W. H. Woods, charge shift engineers; R. S. Good and N. H. Thomas, sub-station superintendents, and Mr. R. Thomsen, charge shift engineer.

General.

Blackburn.—The Electricity Committee have decided to grant the borough electrical engineer (Mr. P. P. Wheelwright) an honorarium of £500 for special work carried out in his own department in connection with the war.

Edinburgh.—At the meeting of the Electric Lighting Committee last week, the electrical engineer (Mr. F. A. Newington) reported that there was now an e.h.t. converting plant at M'Donald-road station, and that with the provision of some e.h.t. switching gear at Dewar-place station he would be able to effect a considerable economy during the four or five summer months. The saving is expected to be over £1,000 a year.

At a special meeting of the Electric Lighting Committee on Friday, Sir Alex. Kennedy attended and explained the present position of the Portobello station. The Committee decided to instruct him to prepare [illegible] it fulfils all the requirements of the Coal Conservation Committee for the erection of a big super-station capable of supplying an almost unlimited [illegible]

Electrical Power Engineers' Association.—A meeting of the Council of the London Division of this Association was held at St. Bride Institute on the 13th inst.

[illegible] were present, the president (Mr. A. C. Bostel, Croydon) in the chair.

The hon. secretary (Mr. W. A. Jones, Leyton) reported a gratifying [illegible] work the three divisions are now engaged.

[illegible]

a general consensus of opinion that the existence of two organisations [illegible]

Exeter.—[illegible]

Financial Assistance to Electric Power Companies.—In reply to a question in the House of Commons on the 14th inst., Sir Worthington Evans said no subsidy had been granted to the Shropshire, Worcestershire & Staffordshire Electric Power Co. The Ministry of Munitions had made loans against security to the company, their policy being to assist in cases where it was essential that more power should be available for munition purposes.

Glasgow.—An arbitration tribunal sat last week to consider the application of the women workers in the tramways department for an increase of the bonus recently granted them. The present application was for a bonus of 15s. per week, including the 3s. already granted.

Hove.—The salary of the borough electrical engineer (Mr. C. B. Smith) has been increased by £100 per annum.

Kilmarnock.—Sir Alex. Kennedy is to report on the electric supply undertaking.

Electric Traction.

Birmingham.—By statute the Corporation are compelled to supply a tramway service at two miles for 1d., and application has been made to the Board of Trade to reduce this limit.

Bradford.—Owing to a dispute as to the interpretation of the recent award by the Committee on Production on the claim of the transport workers to an increased war bonus, the whole of the [illegible] of the municipal tramways department struck work on [illegible] and the service was suspended until Wednesday.

Brighton.—In consequence of the recent award of a war bonus of £1 a week each to the tramway employees, it is proposed to increase fares.

Doncaster.—The Committee dealing with the striking of members of the National Amalgamated Union of Labour discontinued the [illegible] last night the dispute is ended. The [illegible] Tuesday.

York.—At the meeting of the Corporation on Monday, Ald. Meyer stated that more people were travelling on the tramways, but the expenses were increasing more rapidly than the receipts. The Committee [illegible] the fares and would watch carefully the effect.

Foreign Notes.

Electric Smelting in Sweden.—The Swedish Board of Trade recently [illegible] the [illegible] Department a report on the activity of the mining and iron and steel industries in 1916.

The production of electric pig iron amounted to 41,782 tons, an [illegible] 9,797 tons. [illegible] two new smelting works were [illegible] the largest plant is situated at the [illegible] electric smelting furnace in the [illegible]

Swedish Electric Wire Restrictions.—A recent Swedish Royal Decree provides that for the manufacture of such electric wire enclosed in an insulating substance as contains a conducting area of 6 sq. mm. or less, copper shall not be used without a licence from the [illegible] Committee of the Industrial Commission.

[illegible] of the regulation is to ensure that copper shall only be [illegible] where substitutes are not available. It has also been [illegible] zinc can conveniently be used as a substitute for copper [illegible] the supply of zinc in Sweden is abundant, and that the [illegible] of zinc electric wire has been taken up in Sweden.

Miscellaneous.

British Industries Fair.—We learn that, generally speaking, good [illegible] has been done at the Fair, which is being held at the [illegible], London, E.C., and which closes this (Friday) evening.

[illegible]

Education Bill.—The Education Bill was read a second time in the House of Commons on Monday. The new Bill, which is substantially the same as that of last year, will effect important educational reforms, including the raising of the school age and the introduction of a system of continuation classes until 18 years of age.

The Engineers' Club.—The annual general meeting will be held on the 5th prox. to receive the report of the committee, to elect officers, &c.

The Marconi Wireless Contract Case.—In the House of Commons on Tuesday Sir Charles Hobhouse and Sir Henry Norman made personal statements in regard to the Marconi Contract case (reported in another column). Both emphatically denied that they had made any offer to the Telefunken Co., and expressed regret that they were not afforded an opportunity of denying on oath the statements made in the Telefunken Co.'s letter.

Tenders Invited.

Turbo-Alternator, Surface Condenser, &c.

The Electricity Committee of Aberdeen Corporation invite tenders for the supply, delivery and erection of one 5,000 kw. turbo-alternator, surface condenser and appliances. Specifications and form of tender from the city electrical engineer, Mr. J. Alex. Bell, to whom tenders must be delivered by noon April 9. *See an advertisement.*

Static Transformers.

Manchester Electricity Committee require tenders by 10 a.m. April 2 for the supply and erection of three 3,000 k.v.a. 33,000-volt three-phase static transformers. Specifications, &c., from Mr. F. E. Hughes, Town Hall, Manchester.

Boiler Economiser, &c.

Darlington Electricity Committee require tenders by March 9 for the supply of a water tube boiler, economiser, cooling tower, motor-driven induced draught fan and steam turbo-feed pump. Specifications, &c., from the Borough Electrical Engineer.

Electrical Stores, &c.

Tenders are required by March 30 for six months' supply of electric fittings, oils, &c., for the Midlothian-Peebles Asylum, Roselynlee. Forms of tender from the Clerk and Steward, 19, Heriot-row, Edinburgh.

Dundee Corporation require tenders by March 27 for 12 months' supply of electrical and general stores. Specifications from the head offices of the department.

Railway Stores.

The Lancashire & Yorkshire Railway Co. require tenders by 10 a.m. March 25 for 12 months' supply of signal, telegraph and electric light wires, signal telegraph and electric fittings, &c. Particulars from the Stores Supt., Osborne-street, Manchester.

Business Items.

Mr. A. J. Cunningham (founder of Harraway Bros. and director and secretary of Harraway Bros., Ltd.), and Mr. J. Wynn Slater have joined forces, and in future the business will be known as Cunningham, Slater (Ltd.), with branches at 45, King's-road, Chelsea, and 146, Kensington High-street, S.W., the latter being the head depot and registered offices. All assets and liabilities will be carried over. Both Mr. Cunningham and Mr. Slater hold commissions as lieutenants in H.M. Forces.

General Electric and Fraser & Chalmers Amalgamation.—In a circular letter to the shareholders of Fraser & Chalmers (Ltd.) it is stated that negotiations have been practically completed for the sale of the Erith works. In the sale is comprised the goodwill of the manufacturing business, including the construction of turbines, dry gas cleaning plant, and plant for the storage and handling of coal and ores. Fraser & Chalmers will retain the goodwill of the business in mining, milling and metallurgical machinery, with manufacturing rights, and also the merchanting business in South Africa and the agencies for British and American manufacturers. The purchase price, which will be payable in cash, has not yet been ascertained, as it depends upon valuations to be made.

Plaited Flexibles.—The Vulcan Electric & Mechanical Co. (Ltd.), Granville House, Arundel-street, W.C.2, has recently placed on the market the new Vulcan d.p. plaited flexible, for which several advantages over all standard types are claimed.

[illegible] quick wiring, gives better insulation and [illegible] than the [illegible] The Vulcan plaited flexible [illegible] pure rubber, [illegible] and pure and double vulcanised. The [illegible] supply wires and cables, flexibles, conduit tubes and fittings, switches, &c.

Resistance Nets.—The Cressall Mfg. Co., Stamforth-street, Birmingham, has issued leaflet No. 10, giving particulars, with prices, dimensions and ratings, of their electric woven wire resistance and heating nets. [illegible] of British manufacture.

Companies' Meetings and Reports.

AUTOMATIC TELEPHONE MFG. CO. (LTD.)—The profit for 1917, after estimating excess profits duty and contingencies is £46,826, and with £14,774 brought forward the total is £61,600. Deducting directors' fees (£2,450), depreciation on patents, goodwill, buildings, &c. (£10,000), underwriting commission on shares (£4,000) and preference dividend (£12,000), the available balance is £33,150. The directors recommend payment of a dividend on the ordinary shares at the rate of 6 per cent. (less tax) for the year (£21,600), carrying forward £11,550. Government orders and other work of importance kept the factory fully employed, working day and night shifts at high pressure. Valuable assistance has been rendered by the Company's expert technical staff to the Government on problems affecting the National situation. No new telephone installations for public service have been undertaken during the year, but the installation at Leeds is now finished, waiting for the Post Office to put into service, and it is understood that the public automatic telephone service will be available to the City at an early date. Several smaller exchanges have been undertaken during the year for Government departments, [illegible] to give satisfaction to the users.

BRITISH ALUMINIUM CO. (LTD.)—The profit for 1917, after making provision for excess profits duty, [illegible] investments, &c., is £423,663, and with balance brought forward (£26,926) the total is £450,589. After providing for income tax, legal expenses, depreciation of investments and furniture, &c. (£103,115), the prior lien debenture service (£48,000) and debenture stock service fund (£43,224), placing £70,000 to depreciation and £75,000 to reserve, the balance is £111,250. Dividends [illegible] on the ordinary share capital, have been declared, leaving to be carried forward £33,214. The reserve account is now £400,000, and with the £70,000 now added [illegible] £380,000. The hydraulic works at Kinlochleven, for the provision of additional water supply to the Blackwater reservoir, were sufficiently completed [illegible] are now practically complete and the manufacture of hydrate of alumina [illegible] large increases during the year, owing to the continued heavy increases [illegible] ment for the necessary powers to develop a further large water power in Scotland, situate in the County of Inverness, in proximity to the Kinlochleven factory.

BRITISH L. M. ERICSSON MFG. CO. (LTD.)—Mr. D. M. Crowe, who presided over the meeting [illegible] was the largest in the history of the Company. The trading profit was £93,187, or £23,373 more than in 1916. [illegible] common with a number of other companies, taken up a new industry, which, if liberally and fairly treated by the Government, ought to bring [illegible] line; they had taken it up seriously and intended going on with it. [illegible]

BRITISH INSULATED & HELSBY CABLES (LTD.)—[illegible]

shares, making, with the interim dividend already paid, a total of 15 per cent. for the year 1917, together with a bonus of 10 per cent. which will absorb £87,500, carrying forward (after making provision for estimated liability for excess profits duties) a balance of £84,792. The works have been exceptionally busy during the past year. The sum of £180,000 has been placed to the reserve fund, and it is the directors' intention, subject to the consent of the Treasury being obtained and to the approval of the shareholders, to issue bonus shares by the capitalisation of £500,000 out of reserves, in the proportion of one new fully paid ordinary share to the holder of each old ordinary share.

CALLENDER'S CABLE & CONSTRUCTION CO. (LTD.)—In a circular to the shareholders it is stated that the directors have had under consideration the desirability of bringing the nominal issued capital more into accord with the actual funds invested in the business. Owing to the prudent policy adopted for many years past a surplus has been accumulated (apart from the reserve) which exceeds the total issued ordinary share capital. It is therefore proposed that there shall be issued to the ordinary shareholders a new ordinary share in addition to each share held. It is also proposed to sub-divide the shares (both preference and ordinary) which are of the denomination of £5 each, into shares of £1 each. In order to carry the scheme into effect, it will be necessary to increase the authorised share capital, and it is proposed to take powers to raise this from £500,000 to £700,000. After providing for the distribution above mentioned, there will remain unissued £150,000 in share capital. The consent of the Treasury is required for the scheme.

CHARING CROSS, WEST END & CITY ELECTRICITY SUPPLY CO. (LTD).—The report for the year ended Dec. 31, 1917, states that the gross earnings of the West End undertakings from sales of current, rents, &c., were £165,136, against £150,473 in 1916; the expenses (excluding depreciation) were £103,268 (against £78,831) and the net [illegible] and interest (£4,016) together with £1,140 from general reserve (income) account, the available total is £82,115. After providing for interest on debenture stock (£17,829) and setting aside £22,000 for depreciation, the balance is £42,285, out of which have been paid the dividend on the preference shares (£18,000) and an interim dividend for the first half of the year at the rate of 4 per cent. per annum on the ordinary shares (£8,000), leaving £16,285. The directors recommend that a final dividend be paid on the ordinary shares for the second half-year at the rate of [illegible] be carried forward £8,285. There is now connected to the West End mains a total equivalent of 740,989 (30 watt) lamps: in lighting 462,376; in heating 52,912, and in motive power 225,701 (9,076 H.P.).

The gross earnings of the City undertaking were £212,542 (£176,464); the expenses were £147,153 (£110,909) and the net earnings were £65,389 (£65,555); with £18,000 brought forward the total available is £83,389. After providing for interest on debenture stock, loans and advances (£29,131) the balance is £54,257; out of which has been paid the dividend [illegible] The directors recommend that £18,257 be transferred to general reserve (income) account, and that £18,000 be carried forward. There is now [illegible]

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.)—Mr. [illegible] Braithwaite, who presided over the meeting on Monday, said that no issue of capital was made during the year, the amount expended being [illegible] diture in the year had been swelled by the cost of the inter-connector [illegible]

[illegible] or increased wages and bonuses imposed by some-[illegible]. The staff had all worked in the most loyal and splendid manner to meet all the difficulties which had arisen. Revenue account had again borne the whole of the war expenses incurred. The revenue [illegible] the whole cost of aircraft insurance and every other special war expense. Last year he told the shareholders that an arrangement had been made with the South London Electric Supply Co. to inter-connect that Company's power house with that of the County of London Co. Owing to the extreme delay in getting delivery of plant and material and the difficulty of getting permits, priority certificates, &c., it was not until the 17th inst. that they were able to test the inter-connector. The test was thoroughly satisfactory, and the shareholders could take it that that inter-connection was now established between this company and the South London station, while the County of London's two stations were already inter-connected, and they had inter-connection also with the Sutton station of the South Metropolitan Electric Light and Tramways Co. They were now, therefore, illustrating on a small scale the advantages of inter-connection and centralised generation, and he hoped the example would be followed to a greater and greater extent. In spite of all drawbacks, they had received application in the year for 4,551 kw., while the number of consumers had increased by about 1,000.

[illegible] companies had done well, especially the Coatbridge [illegible] last year sold 1,657,712 units, and was now [illegible] of the subsidiaries. Putting together the figures of the County of London and its subsidiary companies (at Bournemouth, Richmond and Coatbridge) he found that the combined revenue of the [illegible] and its associated companies in the past year was £519,244. The combined sale was 53,688,047 units, an increase of 5,238,584 units over the previous year. The total number of consumers [illegible] of 1,570, [illegible] kilowatts applied for there was an increase of just about 6,000. They had 467 men on active service, including 255 from the County Company alone, of whom he regretted [illegible] wounded. During the latter part of the year the services of Mr. H. B. Renwick had, at the special request of the Government, been partly released to enable him to act as Director of Feeding Stuffs at the Ministry of Food for the organising and distribution of all feeding-stuffs and the rationing of all cattle and other animals, [illegible] compliment to the Company and an honour [illegible] being said about reconstruction, and also all sorts of schemes were about, including schemes for carbonising coal in some way which was going to diminish the consumption enormously. They had not materialised to anything like a perfect form. But, whatever was done, he thought it would be agreed that the electric [illegible] dealt with as a separate entity.

DIRECT SPANISH TELEGRAPH CO. (LTD.)—The report for the year ended Dec. 31 last states that, including amount brought forward, after payment of income-tax and excess profits duty for 1916, the balance is [illegible] dividend on ordinary shares at 5 per cent. per annum (2 per cent. having been paid as interim on Oct. 1), also a bonus on ordinary shares of 2 per cent., free of tax, to transfer to reserve fund £5,000, and to carry forward, subject to special taxation [illegible] charged to revenue £165 and £6,709 [illegible] and superannuation funds.

NEWCASTLE & DISTRICT ELECTRIC LIGHTING CO (LTD.)—The [illegible] 1917 [illegible] £39,121. After adding balance from last year [illegible] interest on debentures and loans (£18,304), the [illegible]. The directors recommend payment of a [illegible] for the year £5,578) the transfer [illegible] redemption fund of £2,539, writing £500 [illegible] to reserve for depreciation [illegible] £13,257 to carry forward. Throughout [illegible] undertakings, suffered [illegible] Mr. Arthur [illegible] to the Board.

New Companies.

[illegible] BIRMINGHAM LTD [illegible]

[illegible] ENGINEERING CO. LTD [illegible]

City Notes.

BROMPTON & [illegible] ELECTRICITY SUPPLY CO. (LTD.)—[illegible] carrying forward £5,217.

CHELSEA ELECTRICITY SUPPLY CO. (LTD.)—The directors have declared a dividend of 7 per cent. per annum on the ordinary shares for half-year, making 5 per cent. for year 1915, and £3,479 is carried forward.

EDISON SWAN ELECTRIC CO. (LIMITED AND REDUCED.)—A petition for confirming a resolution for the reduction of capital from £888,071 to £698,307 has been presented to the High Court.

EASTERN TELEGRAPH CO. (LTD.)—The company announce that owing to continued delays arising from the War in obtaining the necessary returns from foreign stations and administrations, it will be impossible to present the accounts and balance sheet duly audited in respect of the year 1917, during the month of May, when it has been usual to hold the annual general meeting. From the data already received and the estimates based thereon, the directors are satisfied that the net earnings of the year will be sufficient for the usual distribution of profits. They have therefore decided to make an additional payment on May 15 next on the ordinary stock equal to a dividend of 1½ per cent. and bonus of 2 per cent. This will make the distribution for the year 1917 8 per cent. (tax free), the same rate as was paid for the previous year. The usual distribution at the rate of 3½ per cent. per annum (less tax) on the preference stock for the first quarter of 1918 will be paid on the same date. The transfer books of the ordinary stock will be closed from May 7 to 14 inclusive. As soon as the full accounts can be submitted the directors will convene the annual general meeting.

Capt. Henry W. Grant, C.B., R.N., has been appointed joint managing director of the Company.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO. (LTD).—It is announced that, owing to continued delays, arising from the war, in obtaining the necessary returns from foreign stations and administrations, it will be impossible to present the accounts and balance-sheet in respect of the year 1917 during the month of May, when it has been usual to hold the annual general meeting. From the data already received and the estimates based thereon, the directors are satisfied that the net earnings of the year will be sufficient for the usual distribution of profits. They have, therefore, decided to make a fourth dividend payment to the shareholders on May 15 next of 3s. per share, together with a bonus of 4s. per share. This will make a total distribution for the year 1917 of 8 per cent. (tax free), the same as in 1916. The share register will be closed from May 7 to May 14, inclusive. As soon as the audited accounts can be submitted the directors will convene the annual general meeting.

TEES POWER STATION CO. (LTD.)—Subscriptions are invited for £600,000 6 per cent. first mortgage debentures at 98½. The principal, interest and sinking fund are guaranteed by the Newcastle-on-Tyne Electric Supply Co.

The Round Table.

By "kVA."

The last Harmonic was well attended last Friday, and President Wordingham from the chair looked forward to there being greater social intercourse among electrical men in the future. He even spoke optimistically of an Engineers' Club for London!

* * * *

A friend brings to my notice the following instance of British Bureaucracy of which he was the victim. As a private individual he sold to a Government department an instrument which they greatly needed and in 3 months was paid for it. Three months after, came an A.I.D. report passing the instrument for service! Then followed at intervals, forms, sent to his private address, asking for statement of his returns as a contractor, otherwise his future payments would be endangered! His protests that it was an isolated transaction were of no avail. Eighteen months after the instrument had been paid for, an officer called to know why the forms had not been filled in!! Incidentally, to pay this call he had to make a journey of 30 miles out and home, and being on work of national importance of course he took a taxi the whole distance!!!

* * * *

Thirty-Seven Years Ago.

[From The Electrician, March 19, 1881.]

Something for the Americans. The celerity in switching, for which praise is given to the Glasgow Telephonic Exchange, is said to be in a measure due to the presence of mirrors in the panelling of the switchboard, a device which effectually prevents the eyes of the young lady operators from wandering off the boards for more than two seconds together all the time they are on duty. Falling [illegible] consequently instantly seen and attended to.

A Current Breaker.—At the last meeting of the French Physical Society, M. Marcel Deprez showed a breaker which interrupts the current at the precise moment when it obtains its maximum intensity. It is composed of a small rigid lever oscillating on an axis, and, unlike the ordinary trembler, guarded as much as possible from all vibration. The interruption is produced with a movement of 1 [illegible] of a millimetre. The movement of the lever is very slight, [illegible] the number of interruptions considerably increased. Applied to induction coil, this breaker gives better results; moreover, the [illegible] the shape of the voltaic arc up to a certain length, [illegible] become disruptive.

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CONTENTS.

Notes.

Patents and Trade Marks Legislation.

THE President of the Board of Trade, Sir ALBERT STANLEY, recently received a large and representative deputation in regard to the Bills which were introduced the last session to amend the Patents and Trade Marks Acts. Sir GEORGE CROYDON MARKS, in introducing the deputation, explained that, in the opinion of the deputation, the position of patentees had not been fully appreciated by those who drafted the Bills, and that the proposals in reference to trade marks had created alarm. We fear that the statement of Sir ALBERT STANLEY in replying to the deputation will not be satisfactory to those who, like ourselves, see difficulties in the proposed legislation. Sir ALBERT STANLEY stated that the Bills were in the nature of war-time measures, and were introduced with the object of preventing certain abuses, such as perpetual monopolies, which were virtually obtainable under present conditions. Although we have no wish to see perpetual monopolies springing into existence, we suggest that they might be dealt with in some way more suited to the needs of industry than by the methods suggested by the Bills.

"Equality of Sacrifice."

WE regret particularly the attitude of Sir ALBERT in regard to extending the life of patents. The view was expressed that all classes of the community suffered through the war and had to make sacrifices alike, and that it would be impossible to place inventors and patentees in a privileged position; but that if it could be shown that [illegible] had resulted due to the war, while [illegible] had been [illegible] the nation's industry at the expense of the patentee, a patent could be extended. This means in effect that in actual practice only a very small percentage of patents would be extended, for the simple reason that, in the first place, the average patentee would not have sufficient money to carry through the necessary formalities to prove his case; and, in the second place, the number of patents to be considered would render any process of dealing with them individually altogether impracticable. To examine the merits of, say, 50,000 claims (which would probably be less than the number that would be made unless obstacles were placed in the way of the patentee) would require the creation of a large Government Department for this alone if the work were to be concluded within the lifetime of most of the inventors. We see no point in this gospel of sacrifice. Where sacrifices are necessary they should be made, and generally are so, without serious murmuring, particularly if it is shown that it is for the good of the country as a whole that such sacrifices should be made; but in the case of a patentee there is no gain to the community if the life of a patent has been halved owing to the war. On the contrary, we consider that it is a loss both to the patentee and to the community, and therefore bad for the country as a whole, that the bulk of the patents in this country should for a number of years be rendered worthless. If the remedy were not simple it would be another matter, but considering the simplicity of the remedy, and the obvious advantages of applying it, we fail to see any good reason for the attitude taken up by Sir ALBERT STANLEY.

The Coal Conservation Report.

IN another column we give some interesting remarks by Mr. S. L. PEARCE on the recent report of the Coal Conservation Sub-Committee. This is the first reasoned criticism of the report, and it merits serious consideration by engineers, both on account of its moderation and of Mr. PEARCE's position as head of the large undertaking at Manchester. A number of points are discussed in turn, but perhaps that which will appeal most directly to engineers is the great question of the relative merits of a water-side station and of a station employing cooling towers. There is no doubt that every engineer, if given a choice of equal terms, would be in favour of placing his station on a water-side site. The difficulty, however, is that enormous quantities of water are required for really large power stations, and such sites are not easily available. If a station has to be placed at a considerable distance from the centre of the load which it is to supply it then becomes a question between electric transmission on the one hand and the employment of cooling towers on the other. In the case of Manchester, Mr. PEARCE estimates that for a station of 100,000 kw. the cost of transmission would be of the order of £100,000 to £125,000 per annum, whereas the cost of cooling towers, taking into account the increased coal consumption due to lower vacuum, would be of the order of £[illegible] per annum. The conclusion is reached that it would not pay Manchester to have a power station at a distance exceeding [illegible] from the area of supply [illegible]. It is a large question, and [illegible] to the fundamental fact that the bulk of the heat is in the latent heat of steam, and has to be removed in the cycle of operations. If circulating water is available in large quantities, the necessary cooling of the water is effected by [illegible], but if only a [illegible] quantity of water is available for condensing purposes, the cooling must be effected in the towers [illegible]. It is just a question whether [illegible]

stations under our climatic conditions in winter this enormous amount of evaporation might not become something of a nuisance.

Steel in Electrical Construction.

As the size of the turbo-generator increases its design becomes more and more one that involves mechanical considerations, and therefore one involving the use of iron and steel by the mechanical engineer with certain limitations which are set for him by the electrical engineer. It follows that steel in all its aspects is of increasing importance. Work in recent years on the subject of iron and steel has materially changed our conceptions in this direction. The several varieties of steel which enter into the problem are now better known, and, owing to microscopic investigations, we are able to appreciate very much better what happens when steel is quenched and what modifications are introduced by heat treatment and by mechanical treatment in the cold. All this was brought out exceedingly well, and in very instructive fashion, by Dr. S. F. BARCLAY, when he read his Paper last week before the Institution of Electrical Engineers on "The Mechanical Design of the Turbo-Alternator Rotor." As a matter of fact, Dr. BARCLAY did not read his Paper at all, omitting this often tedious formality, and giving us instead a most refreshing summary of current knowledge of steel on the lines above indicated. We commend this form of reading Papers to other authors when occasion arises, for a summary of this kind is extremely useful to those who ought to know something of the subject but have not sufficient leisure to make a study thereof.

Restriction of Electric Lighting.

THE announcement that users of gas and electricity in the south of England are to curtail their consumption to five-sixths of the amount consumed in the corresponding quarter last year introduces a position of considerable difficulty. It takes no account of those consumers who, for patriotism or for lack of money, have already curtailed their consumption as much as possible. It will be extremely difficult for these consumers to go still further. Thus it seems, as has so often been the case, that those who have sought to comply voluntarily with the desires of the authorities will suffer more than those who have not. As far as electric lighting is concerned, we think that the authorities have an exaggerated idea of the amount of energy used for this purpose. Owing to the introduction of the metal filament lamp this consumption has fallen off [illegible] ... in fact it was a common complaint not so very long ago on the part of station engineers that the supply of electricity for lighting was no longer remunerative in many [illegible] of supply taken. If gas and electricity is used for cooking, the case is somewhat different; [illegible] the unhappy position [illegible] in order to avoid [illegible] to cut down their supplies. [illegible]

A Tactless Censor.

[illegible] Ministry [illegible] the Paper

was sent to the Ministry of Munitions on March 2 with a notification that it was intended to read the Paper on the 15th inst. Although the secretary was in constant communication with the Department by telephone, by letter and in person, it was not till 10 days afterwards—namely, on the 12th—that he was informed unofficially by telephone that it was probable that the Paper could not be read on the 15th. On the following day this was confirmed officially in writing. At the same time a letter was received by the President to the effect that the objection to Mr. MORGAN's Paper was "to its general tenor rather than to any particular portions," and that "the question as to whether Mr. MORGAN should have permission to read the Paper is one for the Ministry of National Service, and it will be necessary for you to consult them if you desire to be informed officially as to their attitude." We reiterate that such conduct towards a body of professional men is singularly tactless. Had a similar position arisen in connection with another section of the "engineers" it is probable that no less a person than the Minister himself would have made it his business to deliver an address to a body of delegates. Lest there should be any misunderstanding, it may be mentioned that the Paper submitted to and so tardily suppressed by the Ministry contained nothing but a record of what has been done during the war in the employment of women in munition works, and it would certainly seem that much less than 11 days should have been sufficient to decide a matter of principle. Any business man would have settled the question in a few minutes.

National Kitchens.—We understand that Mr. W. A. Gillott has joined the Ministry of Food in connection with electric cooking apparatus for national kitchens. We are glad to note this step, which should certainly be to the advantage of the industry, and which indicates that something is now being done to remedy the state of affairs to which we called attention in an editorial note quite recently.

Royal Institution.—Among the lecture arrangements at the Royal Institution after Easter, at 3 o'clock in the afternoon, we notice the following: Two lectures on Scientific Signalling and Safety at Sea, by Prof. John Joly; two lectures on Musical Instruments Scientifically Considered, by Prof. Edwin H. Barton. The Friday meetings will commence on April 12th, when Prof. E. C. C. Baly will deliver a discourse on Absorption and Phosphorescence.

Importance of Electricity Supply.—The following resolution is to be moved by the Newcastle Chamber of Commerce at the annual general meeting of the Chambers of Commerce in London on April 10th:

This Association, recognising the urgent necessity to increase the productivity of our industries after the war as the chief means to meet the burden of the war debt of the Nation, and to maintain high wages for the workers, urge His Majesty's Government:

(a) To recognise that the public supply of electrical energy for power, light, traction, heat, electro-chemical and other purposes, is a key industry, insomuch that all other industries are becoming increasingly dependent upon it.
(b) To hasten the amendment of the legislation which has hitherto hampered its efficient development.
(c) To secure the supply at the earliest possible date of ample and cheap electricity for all purposes.
(d) To conserve our coal resources, the chief wealth of the country, by compelling the exercise of the maximum possible economy in its use for industrial, domestic and all other purposes.

And resolves that this resolution be communicated to the Prime Minister, the President of the Board of Trade, and the Minister of Reconstruction.

Industrial Reconstruction.—A plea for the establishment of self-government in industry was made by Mr. Ernest J. P. Benn, the chairman of the Industrial Reconstruction Council, at a well attended meeting at Nottingham University College on March 21st. The Sheriff (Mr. H. Offiler) presided.

In the course of his address Mr. Benn explained why trades needed self-government. After the war increased production would be necessary to raise the higher revenue needed—a revenue that would have to be at least three times what it was in 1914. The prosperous employer w[illegible]

an asset, and the well paid worker a national necessity. The well-being of trade was an entity that it was to the interest of the nation to promote. Trade parliaments or industrial councils would stand between the Government and the trade, to voice the opinions of the whole trade. No Government could grapple with the problems connected with the demobilisation of 10 million soldiers and munition workers, and the re-mobilisation of industry: it could only be done by the trades themselves. In export, combination was imperative. Mr. Benn illustrated this by a reference to the working of the German cartel system, and the American trust system in the Argentine.

Standards of Safety and Quality in Relation to Public Service.—A circular on this subject (No. 68), issued by the Bureau of Standards, Washington, refers to the investigations carried out by the Bureau on public service relations, the preparations of specifications on quality of work, testing and inspection, safety rules, &c. A supplementary bulletin (No. 56) refers to standards for electric service, and deals with such questions as steadiness of voltage, continuity of service, and the reliability of meters. The National Electric safety code, the result of four years of work, includes rules for the installation and maintenance of machinery and plant, and was discussed in some detail in our columns when first issued. Another matter recently dealt with is electrolysis. The work of the Bureau is being continually extended, and it is hoped to present fuller information on street lighting and to complete some studies undertaken on telephone apparatus shortly.

The Use of Incandescent Lamps for Cinema Projection.—In view of the high energy consumption in the electric arc, its great heat and the care needed in its manipulation, attempts have been made from time to time to substitute incandescent lamps for cinematograph projection. A Paper by Mr. L. C. Porter in the "General Electric Review" describes the most recent form, which appears to be giving encouraging results. It utilises a 30-ampere 750-watt lamp, combined with a spherical mirror and a special form of condenser lens, the aim being to concentrate the filament within an area 0·4 in. square. A table is presented showing the advantage of using an objective lens of as large an aperture as possible (preferably 2¼ in.) The lamp is particularly suitable for use on alternating circuits where motor generators would otherwise be required. It is stated that the lamp will give a satisfactory picture on a 12 ft. screen of white plaster or cloth, or a 16 ft. picture on metallic, fibre or glass screens.

Institution of Electrical Engineers.—At the meeting on March 21, Mr. C. P. Sparks presented to the Institution a portrait of Galileo, painted by Sir William Bradley. The President, Mr. C. H. Wordingham, in thanking Mr. Sparks, said the Council had arranged for some notes on Galileo's work in connection with lodestones to appear in the next issue of the "Journal." The President also announced that the next meeting would be a joint meeting of that Institution and the electrical section of the Royal Society of Medicine, at the Royal Cancer Hospital, Fulham-road, at 7.30 p.m. on Thursday, April 11. The following Papers will be read: "Diathermy: The use of Electricity for Heating the Tissues of the Body in Disease," by Dr. E. P. Cumberbatch; and "Single Flash (Instantaneous) Radiography, its Possibilities and Limitations," by Dr. R. Knox. There will also be an exhibition of electro-medical apparatus. The usual informal dinner of the Council and members will take place at the Waterloo Tavern at six o'clock on that evening.

The Employment of Women in Munition Factories.—A Paper on the above subject was read by Miss O. E. Monkhouse before the Institution of Mechanical Engineers on March 15th. The authoress has had considerable experience of the employment of women under the Ministry of Munitions. In her opinion the successful employment of women would need [illegible] that the psychology of the woman worker is different from that of a man [illegible] special treatment and supervision [illegible] of the [illegible] sympathetic attitude. [illegible] women may be [illegible] the domestic and (b) the [illegible] type. These [illegible] approach them [illegible] in a somewhat different way and have different capacities. At present [illegible] women are employed on the production of munitions. The authoress gave an interesting summary of the various difficulties encountered in introducing women's labour and the methods of training employed. Finally, special reference was made to the value of welfare work, which is not only essential to the health and well-being of women workers, but can assist greatly in smoothing the difficulties in beginning work in unfamiliar surroundings.

Electricity and the Nation's Food.—The last of a series of three Chadwick Lectures was given at the Albert Hall, Swansea, on March 22, by Prof. H. T. Davidge on "Electricity and the Nation's Food." The lecturer discussed the direct stimulation of growth by electricity, electrical seed treatment and the destruction of harmful organisms with and without chemical aid. On these points the need for immediate further work was strongly emphasised. While undoubted increases of corn, potatoes and other food stuffs had resulted from direct electrification, the conditions which would make the result certain and economically worth while had not been investigated with the requisite thoroughness. A strong committee had been appointed by the Government, and it was to be hoped that rapid improvement in the conditions of experiment would result. The lecturer laid stress on the gain to agriculture which would follow the projected schemes of cheap, widespread electric supply. Much work of farms, at present done by small isolated power units, such as steam, oil and petrol engines working under inefficient conditions, could be done with advantage by motors driven from high-pressure distribution mains. The necessity for the removal of restrictions on rural supply and for looking at the problem on a non-parochial basis was strongly emphasised. Finally, the lecturer dealt with the necessity for nitrogen fertilisers for wheat, their present shortage and the work of the Nitrogen Products Committee, and the preparation of nitrogenous manures from the atmosphere by electrical means.

An Optical Ammeter for Alternating Currents.—It is well known that when an ammeter is applied to measure the current taken by glow lamps in photometric tests, great accuracy is necessary, because a given percentage error in the current will lead to a very much greater relative change in candle-power. In the "Journal" of the Washington Academy of Science, Mr. Paul D. Foote describes an ingenious reversal of this effect—*i.e.*, the use of a photometric balancing device to measure alternating currents, which is stated to be extremely sensitive. The device consists in comparing two lamps, the current through one (direct current) being accurately determined with a potentiometer, while the second lamp receives the alternating current it is desired to measure. The first lamp illuminates an opal glass screen, and the image of this is brought by a lens into coincidence with the filament of the second. The brightness of the filament of the lamp receiving alternating current is then balanced against the illumination from the lamp receiving direct current by adjusting the latter current with a rheostat, and then measuring it with a potentiometer. The relation between the currents in the two lamps can be determined once for all by an initial calibration with direct current. Henceforth, the value of an alternating current is determined by an auxiliary measurement of direct current. The range of currents which can be measured by any one system is [illegible]. To increase the range other lamps may be substituted. As an illustration of the sensitiveness of the method the author asserts that if a photometric setting is made with an accuracy of only 5 per cent., the current can still be determined to [illegible] parts in [illegible]. It would therefore appear that the method [illegible] for the accurate measurement of alternating currents, especially as it is presumably [illegible] of [illegible].

Arrangements for the Week.

FRIDAY, April [illegible].

[illegible]

The Mechanical Design and Specification of the Turbo-Alternator Rotor.*

(*Concluded from p. 794.*)

By S. F. BARCLAY, Ph.D., B.Sc.

Summary. The author deals first with the relative merits of the solid and laminated types of rotor, the maximum diameter that is permissible and the choice of steel. He then passes on to the design of the shaft, the effect of alternating stresses, the design of end bells and the provision of adequate ventilation.

Rotor End-bells.

As already indicated, the most highly stressed part of the rotor is at the end bells retaining the rotor end windings, and the design of the bells, therefore, requires the most careful attention. In the case of a 5,000 kw. alternator at 3,000 revs. per min. with a 31 in. diameter rotor, at the overspeed of 20 per cent. above normal, the centrifugal force exerted by the windings at each end of the core is about 820 tons. If to this is added the centrifugal force of the bell itself, the total centrifugal force at each end is about 2,000 tons. For such enormous forces it is obvious that the material employed must be very high grade.

In considering the choice of material for the end-bells the designer daturally has preference for non-magnetic material. With the end-bell registering on the rotor core, if it is magnetic it offers a direct leakage path of considerable area from pole to pole, and has an appreciable effect in reducing the useful rotor flux. Before steel bells were tried it was thought that there might be heating in them due to leakage flux from the stator, but experience shows that such is not the case, the reason being that any such flux rotates synchronously [illegible] the bell.

Of the non-ferrous metals available for making end-bells the best is a high grade manganese bronze. Good material of this kind has [illegible] strength of about 44 tons per square inch, a yield point of 22 tons per square inch, and an elongation of 20 per cent. The real elastic limit of the material, as shown by its behaviour under reversals of stress, is lower with regard to the yield point than with a good steel. For this reason the author is of opinion that the maximum stress should not exceed 45 per cent. of the yield point. [illegible] carbon steel can be used satisfactorily for the end bells [illegible] 25 in. diameter at 3,000 revs. per min., but not for any larger diameters. For the smaller diameters, however, there are advantages in favour of using nickel-chrome steel. Of the non-magnetic steels, 25 per cent. nickel is the only kind of which the use [illegible] for end bells.

Whereas with carbon steel oil treatment is desirable, with nickel-chrome it is indispensable. As with the rotor, the end-bell forgings [illegible] and then be heat treated.

[illegible] to the magnetic and non-magnetic end bells, [illegible] the question of a composite end bell. The [illegible] in the axial direction, being least [illegible] at the other end.

Ventilation.

[illegible] that have been tried at various [illegible] distinct types [illegible] axial [illegible]

volume and temperature rise of it can be separately measured. By varying the rotor fan the volume of air flowing through the rotor can be regulated to give the exact volume required. The omission of the rotor axial ducts gives the designer liberty to work to the tooth density he prefers rather than that to which he may be forced. There must be some difference of temperature between the two ends of the rotor, but the volume of air can be made sufficient to keep the hotter end within the desired limit. By suitably disposing the stator ducts the temperature throughout can be kept substantially uniform. In addition, when necessary, axial ducts may be arranged in the stator and the discharge from these into the various radial ducts may be separately varied to further equalise the temperature rise. The omission of the radial ducts reduces somewhat the noise of the alternator and also the windage loss. The author also refers to points which should be borne in mind in the design of fans.

Balance.

Freedom from vibration is an essential mechanical requirement apart from being desirable for more obvious reasons. It is desirable that the degree of balancing should not be left to the judgment of the erecting engineer, but should be put on a positive basis by using a vibration indicator. Much time is saved in balancing, and the final result is often better if the rotor is balanced statically before running.

Overspeed Test.

The stresses and pressures for a given rotor increase with the square of the speed. For proving mechanical soundness the overspeed test fails because it is fatigue failure that is most to be feared, and an increase of speed does not prove capacity to withstand fatigue. The overspeed does directly test the soundness of the rotor teeth and of the end-bells, but even its value in this way is limited, because in the event of there being a flaw, due to the ductile quality of the steel, it is more probable that failure will result after prolonged running than at the moment. A great disadvantage is that the overspeed imposes an undue stress on the insulation that is harmful. The turbine emergency governor should be set to operate at 10 per cent. overspeed, and since some allowance to make sure of the governor operating is necessary, it is desirable that the set should be capable of standing an overspeed of 20 per cent. At this overspeed the pressure and the centrifugal force are 44 per cent. greater than at the normal speed. The author holds the view that all parts of the rotor should be designed as if it were to run at 20 per cent. overspeed continuously. At the normal speed the stresses and pressures are 30·5 per cent. less, so that the factors of safety in the teeth and end-bells are then very satisfactory.

DISCUSSION.

Prof. A. B. Field said the problem under discussion had become primarily a mechanical one, and in the large sets that would be required [illegible] could be accepted more readily than mechanical failure. He thought the author had had chiefly in view 3,000 revs. per min. [illegible] speed a solid forging was preferable. For 3,000 revs. per min. [illegible] beyond about 10,000 kw. could not be expected. The [illegible] the construction he (Prof. Field) described to the [illegible] a couple of years ago. That construction comprised the use of rolled plates about 2 in. thick, rabbeted into one another and into [illegible] at each end, and assembled without any central shaft. [illegible] was proposed by Behrend. The whole construction [illegible] by [illegible] bolts which would compare not unfavourably with [illegible] central shaft. Considering only the bolt section, one had a moment of inertia corresponding with a central shaft 21 in. in diameter. He thought the author's description of the case was mis[illegible] there were large compression areas round the bolts [illegible] in producing the stiffness in question. The [illegible] the deflection was due almost entirely to the elongation of the [illegible] the area of the plate being large compared with the area of the [illegible] and the compression of the plates was therefore negligible. [illegible] took all compression off the plates, and [illegible] of the underside of the rotor the plates were out of contact. If [illegible] were assembled with the bolts loose and [illegible] supported at the journal bearings, the stress on the bottom [illegible] would only be 1,000 lb. per square inch, whereas the stress with

which the bolts were tightened was 10 times that figure. The variation in stress on the bolts was less than 700 lb. per square inch on each side of the flange as the rotor turned round. The longitudinal bolts had a section in 85 per cent. of their length somewhat smaller than that at the root of the thread, and with that construction the centrifugal force of the bolt was adequately taken by the rotor material. At one end of the bolt were a couple of keys which took the torsional effect while the nut was being tightened and on the other hand the type of bolt was such that the required dowelling effect was obtained in the circumferential direction. The author referred to a machine which in 2½ years showed signs of failure. The rating was 6,000 kw. at 1,500 revs. per min. That was not constructed along the precise lines he was discussing, as none of the machines were of such small rating. The author said, "since the bolt area in tension is small compared with the rotor weight, the deflection in the body of the core is considerable, and hence the critical speed is very low." He did not agree that the deflection of the core was considerable on account of the tension in the bolts, because it could be indisputably demonstrated that if the structure were assembled under considerable stresses and then rested on the journal centres, the deflection of such a built-up rotor was exactly the same as a solid rotor with the same slotting and venting, so long as the compression did not vanish on the lower half of the rotor and the stresses were within the elastic limit. The author hesitated to recommend a single forging for the largest sizes of 1,800 revs. per min. machines, and he suggested a hollow forged drum shrunk upon a through shaft. For a 52 in. or 53 in. rotor a 6-in. deep slot was required for the coils and heavy wedges, and below that an air slot—for big machines a 4 in. slot was none too deep. The rotor slotting would thus run down to about 32 in. diameter, and if only a 20 in. shaft were put in, stresses of 45,000 lb. per square inch had to be accepted, ignoring the initial shrinkage stress. There seemed little advantage in the through shaft in that case. It was preferable to accept, say, 28,000 lb. per square inch stress at the smooth surface of the bore than to take somewhat less than half that in the core of metal which was almost glass brittle. He endorsed the author's standard of chrome nickel steel for end rings. In spite of its electrical disadvantages it was the most desirable material in large machines. Manganese bronze was poor in its elastic property. If a bronze tip were used, it should be first checked into the rotor body, leaving a sufficient clearance to allow for radial expansion. The author limited his bronze stress to 45 per cent. of the yield. That gave 10 tons per square inch as a safe limit for the bronze. Was the 45 per cent. high enough? The bronze limit was given as half that of the steel. In the author's composite end-bell the steel was forcibly expanding the bronze and giving it a stress of 68 per cent. instead of 50 per cent. The steel end-ring should not be supported on the projecting slot wedges. There was a variable distribution of coil-loading, auxiliary and circumferential, the rings distorted out of the circular shape and the radial expansion of the ring was often more than neutralised by the distortion from the circular shape and very varying stresses were caused.

Mr. A. H. [illegible] differed from some of the author's statements. He had been responsible for about 1,000,000 kw. of machines with laminated rotors, and there had been no failures from failure of the punchings due to over rolling. He used punchings hardened by cold rolling. The elongation was 10 to 15 per cent., [illegible] by the author. He thought the rolled punchings [illegible] as the steel binding wire. The stresses [illegible] increased, and they were justified in using a material which did not have very high elongation. [illegible]

[illegible]

[illegible] ought to be careful in specifying for losses. The only sound way seemed at present to be to measure the volume of air and the temperature rise to get an idea of the losses inside the machine. It was probably unsafe to run shaft machines on short circuit for any long time. A machine mentioned by the author had a rise of 200°F. in one hour, and that was not final.

Mr. A. R. EVEREST said it appeared to be the author's object to prepare a specification for the guidance of the technical adviser, but the technical adviser should be sufficiently familiar with the subject to express his own preference. It was good to have a standard specification for material, but specifications for the finished product were only adopted as a war expedient, and he did not think one was wanted for the turbo-alternator. The principal objection in the Paper to the laminated rotor was that there had to be holes in the punchings, which weakened them. It was also stated that with a capacity of 8,000 to 10,000 k.v.a. and a speed of 1,500 to 1,800, the punchings became so unreliable that it was necessary to put a shaft through them, which did not seem to agree with the statement that a solid disc was twice as strong as one with a small hole in the centre. There was nothing in the history of the performance of the many laminated rotors in use to justify their condemnation. Good ventilation, which would result in a larger output with a given temperature limit, was an advantage.

Mr. H. W. TAYLOR said he thought an operating engineer reading in the Paper of all the defects in the style in which his machine was made, would wonder how much longer it was going to run. One of the obvious criticisms of the laminated rotor was that the laminations would expand and leave the shaft. The excessive precaution of boring out the inside of the rotor and shrinking it on under heat was not necessary. The elliptical forms of the end rings resulting from radial expansion made the laminations grip the shaft at some places and leave it at others. End bells which left their supports at places remained as a whole concentric and did not throw the rotor out of balance. The high stresses the author mentioned in the laminations were not reached before the stresses in the end bell were reached. The author showed a key underneath a slot. It was quite possible to put the key in the portion of the lamination corresponding to the bolt. It was well known that there was more heating on short circuit than with the corresponding current on load; therefore if one worked on the basis of the short circuit heating figure and the machine came within the guarantee on short circuit, it would be better than the guarantee when on load. The leakage which had been mentioned might be due to the end connections of the stator. These might give rise to excessive heating in the end plate and the end portions of the core. He had never known a rotor to clog up with dirt, but the stators had done so.

The AUTHOR said, in reply to the discussion, he was not sure the final limiting conditions would be mechanical. There might be great trouble with the expansion of the rotor conductors when it came to very big machines. In dealing with 3,000 revs. per min. he had taken the worst case under existing conditions. The whole point with the plate construction was that one relied on the one plate being supported upon the other or upon the bolts. It was difficult to make a really sound fit of the plates, as the [illegible]. As the rotor turned all the stress came on the lower half, and there was a tendency for the rotor to bend. There was no reason why the stress on the inner periphery should not be kept within 9 tons per square inch, and the margin of safety was sufficient. Prof. Field said these large rotors might be [illegible] slowly it was very soft. The limit of the mass of steel which could be [illegible] With regard to the statement that the permissible stress in the nickel [illegible]

[illegible]

Books Received.

[illegible]

Elementary Principles of Continuous-Current Armature Winding.

By F. M. DENTON, A.C.G.I.

Summary.—Continuous-current armature windings are first classified, the nature of the various classes of winding is then explained, and special terms used are defined. The derivation of the usual winding rules is developed by a simple method based upon an understanding of the ordinary Gramme ring. The rules derived apply to multiplex windings as well as to simplex. The use of multiplex windings is discussed, and reasons are given for the avoidance of their use. The simple theory of equalising connections is explained and rules are derived for the application of such connections. Chord winding is explained, followed by the use of interpolated commutator segments, and, finally, special consideration is given to the question of the number of slots that should be used for a given winding, taking into account the inductance of the parallel paths. The article concludes with a schedule of winding rules.

INTRODUCTION.

Although the general theory of continuous-current armature winding is usually found difficult, there is one particular form of winding universally remembered and understood—the simple Gramme ring. This winding is so simple, so familiar and so much esteemed in all our memories that it might not unworthily be called the C.G.S. unit of armature winding. The Gramme ring is, indeed, a fundamental unit, for, as is shown in these notes, every other symmetrical form of winding may be derived from it.

In addition to the derivation of all the winding rules likely to be required in practice for drum windings, the use of equalising connections is discussed, an explanation being given of their application not only to lap windings, but also to the type called series-parallel.

The method of treatment of the subject was first devised by the author for the use of students at the Carnegie Institute of Technology, Pittsburgh Pa., U.S.A.

Fig. 1.

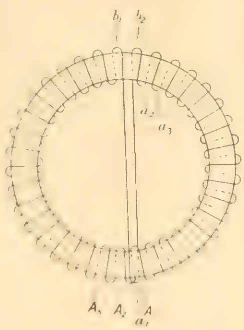

Fig. 2.

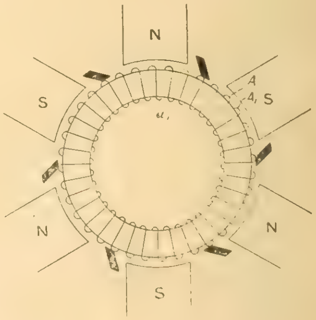

Fig. 3.

Terminology.—No standard terminology having been agreed upon by writers on armature winding, some confusion has [illegible]. The terminology here used agrees with McGraw's [illegible] Handbook for Electrical Engineers, with Parshall and Hobart [illegible] Franklin and Esty, [illegible] and appears to [illegible]. This terminology [illegible] with that used in Prof. S. P. Thompson's [illegible]. The difference lies in the use [illegible] a difference which [illegible] thought of [illegible].

[illegible]

[illegible] may be divided into [illegible]

[illegible]

difficult to construct—the use of former wound coils being practically precluded—and the idle copper inside the ring makes the winding expensive and produces excessive ohmic drop.

Drum windings may be divided into—

(*a*) Lap windings (otherwise called by the more inclusive term multiple-circuit or parallel).

(*b*) Wave windings (otherwise called two-circuit or series).

(*c*) Series-parallel windings (otherwise called multiplex wave).

EXPLANATION OF THE TERMS "LAP," "WAVE" AND "SERIES-PARALLEL."

The lap-wound drum is just a simple modification of the ordinary ring winding. In a ring winding those conductors which thread through the ring are idle, since they cut no flux. By a simple modification these idle conductors may be made active. Let Fig. 1 represent a two-pole ring winding. The idle conductors a may be made active by being laid in the position A. To this end the loop a_1 must be stretched out as indicated in Fig. 2. The E.M.F. due to A_1 will now be added to that due to b_1 and b_2. In a similar manner each idle bar (a_2, a_3) may be made active. The winding thus produced is a drum winding. There are no wires threading through the armature core, this core now serving as a drum upon which the wires are wound.

Figs. 3 and 4 show how a ring winding for a multipolar machine may be converted into a drum winding.* In such a case (in which the machine has more than one pair of poles) the drum winding produced is said to be "lap" wound, the word lap expressing the fact that the wire laps back after every forward step. From the bar b_1 the wire steps forward to A_1; thence it laps back to b_2; thence forward to A_2, lapping back to b_3 and so on.

CONNECTION TO THE COMMUTATOR.

It should be understood that in stretching out the loops of the ring to convert it into a drum winding the commutator connections are supposed to be in no wise interfered with. For obvious reasons the risers by which the commutator bars are

* The method of derivation of the drum winding from the ring is given in [illegible] text book.

joined to the armature winding must be made as short as possible, so that, for instance (referring to Fig. 4a), a riser is made to connect, not the points $a_1 k_1$, but the points a_1', k_1'

MULTIPLEX WINDINGS.

Lap windings are included under the more general terms "multiple circuit" or "multiple wound" and "parallel" windings, which embrace all types of windings in which there are more than two paths through the armature from its positive to its negative terminal.

Fig. 4 illustrates the simplest form of lap winding. The simplest form of any type of winding is called "single" or

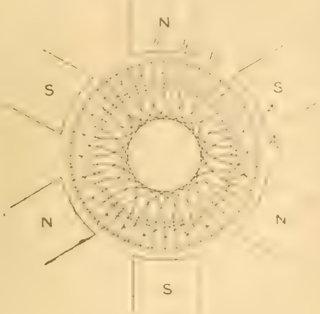

FIG. 4.

"simplex." In order to illustrate the more complicated forms of lap winding, known as "multiple" or "multiplex" lap windings, reference may be made to a multiplex ring.

The simplex ring consists of a single helix (Fig. 1). If two such helices be wound upon the same core, the turns of the one falling in the spaces left between the turns of the other, a "double-wound" or "duplex" winding is produced (Fig. 5). The addition of further similar helices would make the winding "multiplex." When each turn in all the helices has been

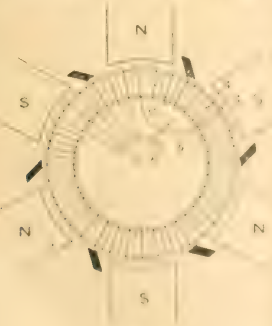

FIG. 4a.

stretched out over one pole pitch, the resultant winding is a multiplex lap wound drum.

RE-ENTRANCY.

A multiplex ring winding need not, however, consist of a number of *separate* helices. For suppose that the pitch of the helix of a ring winding be so chosen that on completion of one journey around the ring the winding does not close naturally, the end missing the beginning by just half of one space (Fig. 6). It is then possible to make a second journey round the ring, and on this journey the winding will join up naturally. The winding thus obtained will later be shown to be equivalent electrically to the winding of Fig. 5, which had two separate helices. Either winding is said to be "double wound" or "duplex." The former is a *singly re-entrant* and the latter, having two separate helices, a *doubly re-entrant* winding.

Similarly, if the pitch of the helix be so chosen that the winding first joins up after three, four or any number of journeys (or "tours") have been made around the ring, we may obtain a "triplex," "quadruplex" or other "multiplex" winding having only one closed helix upon it, equivalent to a winding having a number of separate closed helices.

The number of separate and distinct closed circuits upon a winding determines the order of its "re-entrancy," a winding with but one closed circuit being called *singly* re-entrant; with two closed circuits *doubly* re-entrant, and so on.

Just as a duplex winding may be either doubly or singly re-entrant, and a triplex winding either trebly or singly re-entrant, so also it is not difficult to see that a quadruplex winding may be not only quadruply or singly re-entrant, but possibly doubly. For by proper choice of pitch the helix may be so arranged that the first closing up occurs

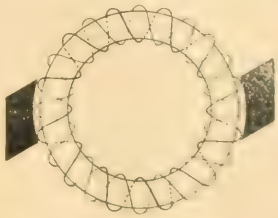

FIG. 5.

after two tours have been made around the ring, and that up to this point only one-half of the winding has been put on. The second half will be similar to the first, its turns lying alternately with those of the first half.

We may go still further, and point out how that a sextuplex winding may be sextuply, trebly, doubly or singly re-entrant, and that in general a multiplex winding of multiplicity m may have as the order of its re-entrancy the number m or any whole number by which m is divisible.

SIMPLEX AND MULTIPLEX WAVE WINDINGS.

Multiplicity and re-entrancy will be dealt with in detail later; they are mentioned now because a knowledge of their meaning makes possible a simple explanation of the types of winding called "wave," including the multiplex wave or series parallel

FIG. 6.

winding. Both these types may readily be evolved from a ring winding having a very high multiplicity. In thus evolving the simplex wave and the series-parallel types of winding it is necessary to consider a ring winding having a degree of multiplicity far greater than would in practice be feasible for an ordinary continuous ring armature. One practical limit to the degree of multiplicity feasible for an ordinary ring winding lies in the thickness of brush demanded. A duplex winding is equivalent to two simplex windings. It may be regarded as demanding two sets of brushes, one set for each of the simplex portions, brush one which, since they must bear, be not midway between the poles, become redundant. In practice, therefore, a duplex winding is provided with the same number of brushes as a simplex, but each brush is made thick enough to make contact simultaneously with both sections (or "planes") of the winding. This arrangement is given automatically

in Fig. 5. A triplex winding requires brushes thick enough to touch all three "plexes" at once, and in general an m-plex winding requires brushes thick enough to touch all the m plexes at once. One limit, then, to the degree of multiplicity is the thickness of brush required, since a very thick brush is apt to make uneven contact and bring commutation trouble.

It is interesting to discover what further difficulties attend the use of a very high multiplicity. In Fig. 7 the multiplicity is so high that, in order to make room for all the "plexes," the pitch of each helix has to be made about equal to one pole pitch.

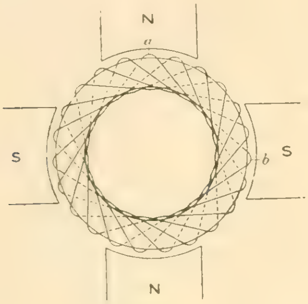

Fig. 7.

The obvious result is that there is no resultant E.M.F. generated in the winding between any pair of brushes (since the E.M.F. in such a bar as a is opposed by that in b); and, further, that if the brushes are made thick enough to touch all the plexes at once, they occupy the whole of the circumference of the armature! Still greater increase in the multiplicity produces the arrangement shown in Fig. 8 and again in Figs. 15 and 31. In these figures the thickness of a brush touching all the plexes at once would be equal to two pole pitches, and again the brushes would short-circuit the whole winding. These remarks apply to multiplex ring windings of whatever degree of re-entrancy.

Referring now to Fig. 8, a singly re-entrant ring winding of such high multiplicity that the pitch of the

[illegible] E.M.F., those of the next tour a greater E.M.F., and so on, those of the fifth succeeding tour having zero E.M.F. again, whilst the E.M.F.s of the sixth and following tours are in the reverse direction.

In order to make use of the E.M.F. due to such a group of cells as is shown in Fig. 9, the best plan would be to connect leads at the points ○ and ○; and similarly to use the armature winding of Fig. 8 brushes should be placed, one at G and one at V, or one at F and one at H, or at W and A, or at any such pair of points. Such a winding as this is called a "series" or a "two circuit" winding, the term *series* expressing the fact that in tracing out the winding from one brush to the next, it is necessary to visit all the polar

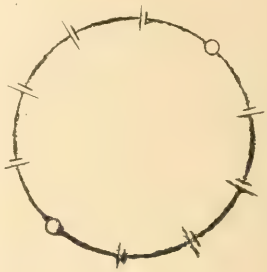

Fig. 9.

regions *in series*, whilst the term *two circuit* indicates that there are *two paths* in parallel through the armature from the positive to the negative group of brushes.

The evolution from such a "series" ring winding to a "wave-wound" drum is almost obvious. The idle bar a in Fig. 8 is made useful by being laid next to A, and every other idle bar is similarly treated. All the bars having thus been brought to the outer circumference the winding is obviously of the drum type; it is called a "wave" winding because of the wave-like (up and down) path followed by the conductors (*see* Fig. 10). A further example of a ring winding suitable for conversion into a simplex wave, is shown in Fig. 10*a*. The conversion would be made by laying bar "x" at "y," and so on.

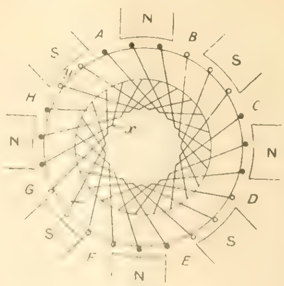

Fig. 10*a*.

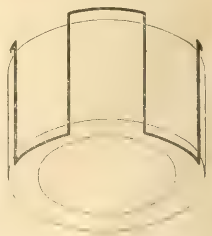

Fig. 10.

Series-Parallel Windings.—Sufficient room having been left upon the armature core a number of separate and distinct windings, each similar to the one shown in Fig. 8 after its conversion into a drum, might be put upon the same armature. The winding so produced would be called a "multiply re-entrant multiplex wave winding" or a "multiply re-entrant series parallel winding." By proper choice of the pitch and the number of turns of a "series parallel" winding, various degrees of re-entrancy may be obtained, just as in the case of a lap winding.

(*To be continued.*)[1]

Electric Power Supply and Coal Conservation.

A debate on the Interim Report of the Coal Conservation Sub-Committee on Electric Power Supply of Great Britain took place at the Engineers' Club, Manchester, on Tuesday, March 5th. Mr. George Hughes presided.

Mr. S. L. PEARCE, who was the principal speaker, remarked that few reports had created such a widespread interest as the one under consideration. It was not his intention to criticise the constitution of the Coal Conservation Sub-Committee, or to inquire into their fitness for dealing with the subject. Rightly or wrongly, the report was believed to be the work of Mr. C. H. Merz, and, for the sake of brevity, he would refer to it as the Merz report. The accuracy of the figures in the report depended largely upon the correctness of 5 lb. of coal per horse-power-hour as an average figure for this country to-day, and of the $1\frac{1}{2}$ lb. which was put forward as possible of attainment. He wished to look upon the report as an endeavour to formulate a national scheme, and, notwithstanding certain criticisms which he was about to make, he desired to say that he agreed with the major portion of the recommendations. Unfortunately, the Sub-Committee's case rested to a great extent on assertions. No data were given as to the cost of super-power stations, nor of the cost of energy nor the cost of transmission. He was sorry to see a distinct bias against municipal enterprise.

Mr. Pearce then proceeded to deal with the report in more detail, and the following is an abstract of his further remarks :—

We will take the first recommendation, which, in effect, is that the present system of over 600 districts, each having its own undertaking, should be superseded by a comprehensive system under which the country is divided into some 16 areas. I wish to correct the impression that the intention of the report is to set up 16 super-stations for the whole of the country. What the Committee have proposed is that the country shall be divided into 16 districts, more or less. Few will contest the soundness of the underlying principle, but without committing themselves to an agreement with a particular number of 16, which is likely to be very substantially increased. The municipal boundary as we know it to-day must be broken down. Economic considerations alone should determine the electrical areas and not local government. The individualistic system must give way to the collective system ; individualities of existing local authorities must be merged into larger councils or joint boards, or other approved authorities, and so with existing companies.

This number of 16 areas was, I believe, taken from the Report of the National Electric Power Supply Joint Committee, which contains the map with England and Scotland divided up into 16 districts. But the delimitation of these areas is purely provisional. I myself thought that the number of 16 was too small, especially with the knowledge that I possess of the work of the Lancashire and Cheshire Committee. In any case, it is quite open for the number to be extended, but we must not jump to the other extreme, and have an area that is too wide and unwieldy.

I now pass to the second and third recommendations—viz., the selection of sites for the new super power station. The Committee suggests that sites should be chosen on important waterways. I quite agree. It is very desirable if you can obtain sites of that char- [illegible] Williamson's Committee, I considered the question of a Mersey-site for Manchester, a site at which it would be possible to obtain ample river water for condensing purposes. I assume a super-power station. The load to be transmitted from that station was 100,000 kw., 0·8 power factor, 66 per cent. load factor, transmission voltage 150,000 volts, which is the highest so far used in the States (and possibly not practicable in this country). But let that pass. Putting the best construction on this problem, it appears that the annual charges on such a transmission line would be of the order of £100,000 to £125,000 per annum. Supposing we were to establish a station in Manchester and use cooling towers it would result in an increased coal bill because it is impossible with cooling towers to obtain a vacuum of more than 27 in. or $27\frac{1}{2}$ in. at the outside, as against the figure of 29 in. or $29\frac{1}{2}$ in. with a natural waterway and plenty of cold water. Therefore, I have assumed an increased coal consumption of 15 per cent. Then, there are all the costs incidental to the towers. I estimate that the extra annual cost for cooling towers compared with a natural waterway are of the order of £70,000 per annum. So that, on the one hand, we have transmission costs of £100,000 to £125,000 and, on the other hand, the figure of £70,000. Clearly in that case it would not pay Manchester to go to the Merseyside for current.

Again, take the question of transmission costs in relation to coal transport costs. Assuming the same data—viz., 100,000 kw. transmitted, voltage 150,000 watts, 0·8 power factor, 66 per cent. load factor—it would only pay to establish power stations 30 miles away from the area of supply if you can get coal 5s. per ton cheaper. On this basis it would not pay Manchester to have a power station at a distance exceeding 20 miles from the area of supply for the purpose of obviating the use of cooling towers, assuming there is no advantage to be gained in the cost of coal.

The above figure of 20 miles could be increased if cheaper coal and ample water were both available, but such sites do not exist in Lancashire. Again, it is difficult to establish a case in favour of transmitting electrical energy rather than railing coal. The superiority of electrical transmission only becomes apparent with very high-load factors.

These two recommendations of the Committee lay too much stress on the suitability of a site to enable them to obtain a low cost at the station 'bus bars ; they have shut out to too great an extent the question of the cost of transmission. Insufficient stress is laid on the desirability of having a station site well situated with regard to the load which it has to supply. Finally, as regards the third recommendation, there I am quite at one with the committee in insisting upon sites being chosen as large as possible in view of the possible adoption at a later date of gas distillation processes.

I now pass to the fourth recommendation, in which the Committee advocate the preparation of plans for the construction immediately after the war of these large super-power plants. I hope that the Commissioners, or whatever Government tribunal may be appointed to select the sites, may be set up as soon as possible. At the present there is already a tendency on the part of various authorities to start pegging out claims in advance. The fourth recommendation, in conjunction with clause 47, contains this sweeping statement : "Existing generating plants are uneconomical and ought to be scrapped." Whilst it is obvious that very many plants are out of date, I do dissent from the policy which seems to be advocated in [illegible] very well go forward together.

[illegible]

yet been satisfactorily answered. This point should be considered in relation to several passages from the last report of the Fuel Research Board, bearing on the above points. The question may have to be put and answered sooner or later: Is the electric consumer to pay more for his electric power supply in order to benefit the nation by conserving the coal supply?

The next and sixth recommendation of the Committee is in connection with waste heat stations. There, I think, there will be practical unanimity with their proposal. Waste heat stations have proved to be very advantageous on the North-East Coast.

Now I come to what is a very contentious point—*i.e.*, the seventh recommendation in the Committee's report in sub-section 7 of clause 48—the question of stopping extensions to all existing stations. That, I think, is too general a statement. The comparison conveyed in Table V., relating to the price of energy in the North-East Coast and Lancashire is very misleading. Mr. Andrew Gemmell, a former secretary of one of the North-East Coast power companies, and a shareholder in one of the companies, has stated in a recent pamphlet: "The average selling price of a ½d. per unit for company enterprise in the North of England in that report, is of little value without stating the companies to which it relates, because one company or group of the existing combination can be made to have the appearance of success with disastrous results to another section of the combination; and it has been the practice of the North of England companies not to give all the statutory statistics which would have shown annually the average selling price."

It is very difficult upon the face of it, to get a true comparison of the rate per unit upon the North-East Coast with the rates in Lancashire. To the casual reader, considering clauses 26 and 27 of Mr. Merz's report, the latter is certainly capable of bearing the interpretation that the reason for the excellent results on the North-East Coast as compared with Lancashire is that it is company control in the one case and municipal control in the other. The first thing to do, of course, when drawing comparisons is to see that you compare like with like. This table does not do so. If you want to get a true comparison, you should compare power units with power units; high-tension units with high-tension units. This is not done in the section of the report referred to. The North-East Coast output is [illegible] a bulk supply, a power supply. Lighting is a very small portion of their business. In Lancashire that is not the case. Take the case of Tynemouth. The figures with regard to this have been given by Mr. Lacey. The bulk supply price to Tynemouth from the Newcastle Company is not 0·5d.; it is 0·64d. These are high-tension units. Now, after transforming and adding distribution charges, the Tynemouth prices are as follows:—

For private lighting	1·05d.	per unit.
For public lighting	1·7d.	„
For [illegible] supply	1·27d.	„

These prices are very similar to those in Lancashire. By way of further argument I may mention a table which I have put in evidence before the Board of Trade. It is an average selection of large and medium-sized towns of Lancashire and Cheshire. The average price per unit sold for industrial power purposes, delivered at the consumer's [illegible] in nearly every case, varies from 0·47d. to 0·68d. The percentage of industrial power units sold in these undertakings varies from 53 to 90 per cent., the Manchester figures being [illegible] per cent.

[illegible] clause 27, the statement is made that on the North-East Coast [illegible] three as much energy per head of population [illegible] In Mr. Sloan's Paper the figure is, I think, [illegible] The comparable figure for Lancashire [illegible] Manchester 211 and for Stalybridge [illegible]

[illegible]

I will go a step further even than the Merz report with regard to the district boards or authorities, and would accord to them certain powers of rectifying boundaries of existing areas, for distribution purposes, and generally vest in them the final approval of the area as laid down for local distribution purposes. I now come to the last section of the Merz report—viz., that dealing with alternative types of new electric power organisations or district authorities. I see no solution along the line of combined ownership and operation by local authorities and companies. Any such scheme will sooner or later break down on the question of finance. The best alternative, I think, is a body of trustees incorporated by Parliament to form a trust on the lines of the Mersey Dock and Harbour Board, in which the traders' interests will predominate, but which does not rule out the possibility of the local authority having representation. In such a trust there are no shareholders and no dividends. I would rule out state ownership and control absolutely. The great point to remember is that it is essential that you should have the same type of board for every district. Regard should be had, as far as possible, to the paramount interest. I am rather stressing this question of public ownership, and in this connection I would again refer to Mr. Gemmell's pamphlet. It is one of the most scathing documents on company enterprise, and I again say if it is wrong no time should be lost in refuting it absolutely; if it is right, then, in my judgment, it will have dealt a heavy blow to private company enterprise as their conductor, because, in his concluding words, Mr. Gemmell refers to the North-East Coast as follows: "Such an electric organisation as exists in the North of England may become, if it is not already, an obstacle to industrial progress."

The report closes with the pious hope that State assistance may be invoked in connection with the establishment of a national system, but it does not give any clue as to the manner in which it considers that financial assistance should be given. Is the State going to advance capital to equip these super-power stations? I have given my view to the committee appointed by the Board of Trade. I hold that much more effective assistance could be given (if the State have any money to give away) if it is applied to writing off a debt on obsolete plants which undoubtedly exist to-day in many stations; in any case there is a very big outlay to be faced. That of itself will militate against any very early drop in the price of electricity.

Annual Report of the B.E.A.M.A.

In the report of the B.E.A.M.A. for 1917, it is stated that the year has been marked by the increasing attention given to the necessity for combination or co-operation.

While our export trade continues to be necessarily restricted, it has been possible to maintain certain overseas connections, and in some instances to supply the demands hitherto met from enemy sources.

The Overseas Committees abroad have been engaged in consolidating previous work, and standard conditions of contract are being more extensively used by Government Departments and Municipalities, especially in Australia and South Africa. The Australia Committee has been of assistance in connection with income tax and import duties and has made valuable reports on American and Japanese competition. Similar reports have come from the South Africa and India Committees and it is hoped that, acting on the advice of the Main Export Committee, the Overseas Committees will be able to secure that some form of control over the importation of foreign accessories shall be enforced. As a result of action taken by the Australia Overseas Committee, the conditions of certain contracts for the Victorian Railways have been modified to give British at least an equality of opportunity with American, Japanese, or other foreign manufacturers.

The question of the piracy of trade marks has also been taken up with the Dominion Governments. The South Africa Committee is co-operating with the local Standardisation Committees of the E.S.C. and also with the Association of Municipal Electrical Engineers (Union of S. Africa) in standardising rules and regulations for electrical supply. The Committee has also been active in other directions. In India, owing to the action of the local Overseas Committee, there is a growing tendency to rely on British electrical manufacturers. Useful reports have been received from the Argentine Overseas Committee, and, largely owing to their initiative, a strong electrical sub-section of the Chamber of Commerce has been formed. The Committee is also working in close co-operation with H.M. Commercial Attaché.

[illegible] to record that several of the Association's recommendations to the Board of Trade Electrical Trades Committee in 1916 have been embodied in the recently created Department of Commerce [illegible] particular in regard to a larger number of Trade Commissioners and Commercial Attachés being appointed and their status [illegible]. The three Trade Commissioners since appointed in Australia, [illegible] and South Africa were invited, before taking up their [illegible] Export Sub-Committee charged with the duty [illegible]. Reports have been received from the [illegible] Committee contrasting unfavourably the position of [illegible] Trade Commissioners with that of American Commercial Attachés.

Methods of assessing income tax and customs duties in British Overseas Dominions, particularly in the Commonwealth of Australia, have engaged the attention of your Export Committee. The [illegible] Overseas Committee supported successful action taken by other bodies in resisting the imposition on British manufacturers represented in Australia of a Federal income tax assessed on an assumed five per cent. profit on sales, which tax would have been in addition to the Australian State income tax and the income tax paid in this country and, therefore, a triple income tax.

Representations have also been made to the Federal Australian Government as to the present method of assessing import customs duties, which impose hardships on British manufacturers. It is urged that, whilst duties assessed on the home market value at the time of shipment may be quite fair when applied to goods shipped within a short period of the date of order, they act unfairly when applied to machinery or apparatus which cannot be shipped until a considerable period of time has elapsed. The matter is under consideration by the Minister of the Department. The New Zealand Government have agreed to change the basis of assessing dynamos and motors from *ad valorem* to "weight" as an experiment.

The Association has adopted the principles of the new British Standardisation rules for export work, and the Association's export Standardisation rules have now been translated into Spanish, Portuguese, Russian and Chinese.

Representations have been made to both the Board of Trade and the Foreign Office in connection with proposals emanating from enemy countries to export their goods after the war through Switzerland or other neutral countries. The I.E.E. Conditions of Contract have now been firmly established as the standard for the home industry.

Arrangements have been completed between the Association and the Institution of Electrical Engineers whereby research into the problems of insulation is conducted jointly by the two bodies, both of which now communicate with the Government Department of Scientific and Industrial Research through the "Electrical Research Committee." The research on corrosion of condenser tubes, conducted by the Association in co-operation with the Institute of Metals, is making satisfactory progress. Other subjects of research are now under consideration.

A Committee was set up during the year to consider the question of technical education in its relation to the electrical and allied industries. The work is being carried out in four parts. Proposals of the turbine and turbo-generator sections respecting research scholarships are being entrusted to the care of this Committee. A scheme is also being considered to provide for the formation of central and local Committees to deal with the selection, placing and training of suitable overseas students.

Your Association continues its representation on the British National Committee of the International Electro-technical Commission and on the British Engineering Standards Committee in its Sectional Electrical Committee, and its Sub-Committees and Panels dealing with standardisation rules, prime movers, graphical symbols, nomenclature, instruments, meters, heating and cooking apparatus, lampholders, and various accessories. During the year, representation has been established on new committees and panels dealing with the gauging of machine parts and screw threads, and the electrical details of ship and aircraft equipment. Your representatives took part in the British-American conference on electrical standardisation, in which further progress was made towards complete agreement on the texts of the American and British standardisation rules for electrical machinery. The Engineering Standards Committee has arranged that British standards specifications will, in future, be issued in a more convenient size and at a popular price.

A Committee was appointed during the year for the purpose of studying questions of common interest to members relating to estimating and accounting.

Your Association appeared before Lord Buckmaster's Pre-war Contracts Committee, and presented evidence of pre-war contracts. The report of the Committee is under consideration by your Council.

Your Council has made representations in the proper quarters as to the desirability of establishing a National Proving House whereby electrical machinery and devices may be certified as complying with appropriate rules, and as to concentrating such rules in the hands of one competent authority.

The report of the Coal Conservation Sub-Committee has been referred to an expert committee, whose report is shortly expected.

Liberal gifts of machinery and apparatus were made by members to the equipment of the laboratories and shops of [illegible] University, but the war has delayed installation.

On a recommendation from the Sectional Board, your Council added the name of the Association to the numerous bodies supporting the proposal of the British Empire League for an Imperial Trade Mark of Origin, but with the provision that the use of the mark would be a national one and [illegible].

The creation of a [illegible] Board composed of members closely connected with the work of the various sections was [illegible] out during the year. [illegible] with Government Departments and done much useful work. The Dynamo and Motor Section has been conferring frequently with the Electrical Power Department of the Ministry of Munitions through an Advisory Committee, and has obtained an Order in Council prohibiting the import of motors. Work in the direction of co-operative purchase and the settlement of special conditions with special bodies has been extended during the year.

During the year your Association has joined the Federation of British Industries and has continued its support of the British Empire Producers' Organisation to which it was previously affiliated.

The system of tendering embodied in cross-tendering agreements continues to find favour among members, and has been further extended during the year. The Association has in operation the following such agreements: (1) Steam-Engine Builders and Dynamo Makers; (2) Diesel-Engine Builders and Dynamo Makers; (3) Condenser Makers, Steam-Engine Builders and Turbine Makers. The work of the Association's status inquiry agents, the British Traders' Association, is under review by the Estimating and Accounting Committee.

The number of members on the register at the end of the year was 178. Thirty-three firms were admitted to membership during the year, and one resigned.

Scottish Local Section of the Institution of Electrical Engineers.

At the meeting held at Edinburgh on March 12th, the chairman, Mr. A. Page, announced the Committee's nominations for office bearers for next session as follows:—*Chairman*: J. F. Nielson; *Vice-chairmen*: Alex. Lindsay and W. B. Hird; *Committee*: Messrs. McWhirter, MacLeod, Sayers, Mavor, Goslin, Hampton, Wood, Mitchell, Anslow, Belsey and Maxwell.

The Chairman expressed regret at the absence of Mr. Jacobs owing to family bereavement, and called on Mr. Wood to read a summary of Mr. Jacobs' Paper on "Electric Signalling and Control on Railways." The following discussion took place:—

Mr. C. E. COCKBURN (G. & S.W. Railway, Glasgow) said that colour problems entered largely into signalling problems and from that point of view he advocated the disc as against the semaphore. Some people thought that if they put in an electric system they had done everything, but that was not so. They would still have mistakes. The lock and block system was enormously better than ordinary block working, as the former enabled accidents to be traced to their source in some particular individual or place. Too much could not be expected from tracks owing to unforeseen flaws making the track inoperative. On single lines he wished electricians could arrange to use the rails to actuate the control.

Mr. BOATH (N.B. Railway, Edinburgh) said that the Great Western Railway had been the first to use lock and block. He was interested in the question of train control, and railway officers were grateful for what electrical people were endeavouring to do to help them.

Mr. SHEWAN (Edinburgh) said Mr. Jacobs had brought forward an important point in connection with the track circuit, viz., its reliability under certain conditions. He did not agree, however, that tracks could be classified. The initial and maintenance costs of the high voltage track circuit seemed to render it prohibitive. Instead of the present system he suggested doing away with the volt drop and operating by the current increase in the circuit due to the train shunt coming on the circuit. In the past, circuiting engineers had been too conservative, sticking to and improving old methods rather than looking for new processes.

Mr. DONALD S. MUNRO (Edinburgh) thought the subject too big for one paper, but said it called attention to the need for discussing the whole question of railway electrification. He advocated the inductive alternating magneto generator as being specially applicable to block signalling work. Track circuiting conditions would change when rails were bonded for earth return for electric traction.

Mr. SEDDON (Edinburgh) asked if signalling direct to the locomotive had been tried by running over insulated tracks operated by various values of current from the cabin.

Mr. WOOD, in reply, said that Mr. Cockburn seemed to have in mind more a shunting signal than a running signal. For through running signalling, however, the three position signal gave a much clearer indication to the driver of the line ahead. [illegible] had brought about the [illegible]. He thought that the magneto generator would be too complicated on the mechanical side.

Effect of Insulation on Steam Drums.—The "Electrical World" describes an interesting test for determining the loss of heat by radiation from boiler settings and steam drums. The 500 h.p. B. & W. boiler tested had steam drums covered with one course of common brick. A rectangular can containing a measured amount of water was placed on the top of one drum and the boiler was run at its rated capacity for three days, the rise in temperature of the water being noted. A course of Armstrong's [illegible] insulating brick [illegible] in. thick was then placed on top of the common brick covering and readings repeated. The result showed that the saving in heat radiated converted into the equivalent consumption of fuel per year would be more than enough to pay for the cost of the insulating brick and the labour required for its installation.

The Electrician.

FRIDAY, MARCH 29th, 1918.

[illegible] and Publishing Offices:—

8, BOUVERIE STREET, LONDON, E.C. 4.

[illegible] Telegrams: "Benbrotric Fleet London."

Some Evils of Government Control.

The statement of Sir ERIC GEDDES last week in regard to shipbuilding was more reassuring than many people had anticipated. Some of the difficulties of co-ordination were mentioned, and it will be admitted by every fair-minded man, that not only are there many such difficulties, but that there must inevitably be difficulties in the carrying out of a national programme of the kind desired. The great trouble in all national work of this character at the present time is that the needs of the country must be considered as a whole. It is useless to make it easy for one branch of activity at the expense of another if the second is equally desirable for the country. It is probably forgetfulness of this fundamental fact that often gives rise to criticism, and it is the realisation of this fact that has led to the building of merchant ships forming part of the shipbuilding programme as a whole, including all the needs of the Royal Navy. It is obvious that it would be useless to build numbers of merchant ships unless the Navy were sufficiently strengthened to look after them. Equally, it would be absurd to put all our resources into building for the Navy without making good the losses which we are sustaining from submarine warfare. It is essential that a middle course should be steered, and for this purpose it is necessary to consider together the three main factors which, according to Sir ERIC GEDDES, are the provision of craft for destroying submarines and for safeguarding ships at sea, the salvage and repair of damaged ships, and the building of new merchant ships. It is impracticable to consider one of these claims apart from the others. In addition to these simple competing claims, there are many others more or less pronounced, to which we need not refer.

Nevertheless, we think something was lacking from the statement of Sir ERIC GEDDES in that no further information was given as to the relations between employers and employed at the dockyards. Notwithstanding what has been told us, there still seems to be some other reason why the output of ships should have fallen in such a marked way at the beginning of this year. Some of the facts became [illegible] in the debate which followed, but there is no [illegible] may be [illegible]. For example, Mr. McKINNON WOOD referred to the [illegible] and Mr. [illegible], a Labour Member, referred to [illegible] and [illegible]. [illegible] certainly may have a very disheartening effect and leads to inefficiency. There is no question, in our opinion, that Government control should be only on broad lines, as a control of policy rather than a control of details. In other words, have some trust in the manufacturer; tell him what is wanted and let him get the results in his own way. On the other hand, it must not be forgotten that, under present conditions, control must extend to the provision of raw materials. It is for the Government to allocate these materials in the way in which they think best; and without such allocation it would be practically impossible for shipbuilders to make any headway at the present time.

As far as controllers themselves and heads of departments are concerned, all these points are, no doubt, thoroughly well appreciated, more particularly as such duties are increasingly in the hands of men who have had wide experience in private enterprise. When, however, we come to those in humbler positions, to those who have always been Government servants, we fear there is trouble from two causes. In the first place, there seems to be an extraordinary tendency for any Government department to be jealous of any other Government department carrying out similar work. It is extraordinary, and indeed almost unthinkable, that jealousy of this kind should exist at a time of national peril, and that the glory of a department, if it can be so described, should have precedence of the country's welfare. In private enterprise there is no time for a feeling of this kind, and we need scarcely say that it would never be tolerated. It is time that any such feelings should be swept away from Government services. Apart from this, there is another weakness which is constantly found; this is due to the fact that a Government official will generally avoid accepting any responsibility. He will refer the matter to his senior, and his senior in turn will refer it to someone else. In other words, red tape springs up—the red tape which has always been an intolerable millstone around our Government departments. In private enterprise a man accepts responsibilities and takes the consequences. Thoroughly efficient Government service will never be reached until the Government servant is equally willing to accept responsibility and to accept the consequences.

Now, defects of this kind give rise to absolutely inefficient working. An example of Government control, probably on these principles, given in "The Times" of last Monday, by Mr. P. G. DONALD, managing director of Rownson, Drew & Clydesdale, is so illuminating that we reproduce it herewith. It is stated that the goods could have been delivered in six to eight weeks. Due to the "control," the period occupied was seven months. The Government Departments concerned are indicated by the letters A to H.

The record is as follows :—

[illegible]	Dept. A orders for urgent work in France.
[illegible]	Dept. A offers to arrange delivery with Dept. B.
[illegible]	Dept. A are advised that 25 per cent. of the goods ready.
[illegible]	Dept. A state they cannot assist in moving the goods, and [illegible] another Dept.
[illegible]	Dept. C, we are informed, will give us permit.
25/4/17	Dept. C asks to see original Government order.
[illegible]	Dept. C refuses to assist.
[illegible]	Dept. B, after three weeks delay, state assistance will be given [illegible].
[illegible]	Dept. C wakens up and asks explanations why we [illegible] from the market we did.
21/5/17	Dept. A state must have delivery.
19/7/17	Dept. D has to be written to for further permits.
[illegible]	Dept. E [illegible] part of the goods because Dept. D has [illegible].
[illegible]	Dept. B refer us to Dept. F over the matter.
[illegible]	Dept. D asks "How dare we ?"
[illegible]	Dept. D asked by us to "give permit for the balance of order."
[illegible]	Dept. D state further permit must be sanctioned by Dept. G.

24/8/17	Dept. H written to as instructed by Dept. D.
25/8/17	Dept. H states we should apply to Dept. A.
28/8/17	Dept. D state cannot help us unless Dept. F does.
30/8/17	Dept. D still regret cannot assist us.
3/9/17	Dept. E seizes goods.
17/9/17	Dept. D sends permit.
5/11/17	Balance of goods received.

The reading of this detailed example leads to the conclusion that such matters are handled by people who do not realise that time is quite as important as money, and that to toss an inquiry about from one department to another is not business. In other words, the record reveals hopeless inefficiency. Why should it take three months to discover that Department D must act and then another two months for that Department to take action? Is this the sort of record that helps to win the war or to maintain the industries of this country? We fear it is forgotten that shipbuilding and all essential products depend upon thousands of manufacturers, and if these are delayed by incompetence in this way, discouragement and diminution of output are inevitable.

How far these various causes may have accounted for the falling off in shipbuilding during the past two months it is impossible for us to say. If, however, there are further questions between employers and employed bearing upon the matter, we think the Government would be well advised to appoint a Commission to inquire into the facts of the case. This need not take long. Last year Commissions were appointed to inquire into the causes of industrial unrest; the work was well done and was accomplished in a remarkably short time. If similar Commissions were appointed, and were to visit each of the main shipyards, we do not doubt they would very soon reach conclusions as to the difficulties experienced by both employers and employed, and the result might be eminently beneficial.

Problems in Atomic Structure.

(Concluded from page 752.)

We continue our account of Sir J. J. Thomson's Royal Institution lectures.

The views expressed, Prof. Thomson said in the fourth lecture, might be tested by experiments on atoms, in the first instance of monatomic gases like helium, in which there was no difference between atom and molecule. Let Fig. 2 represent a helium atom with two positive charges at the centre C and two electrons at A and B at distance d from C. When another + charge approached from D (in line with the electrons) A would be attracted, C repelled, d hence be changed. The system would assume polarity like a magnet, the

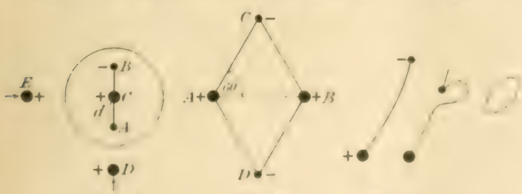

FIG. 2. FIG. 3. FIG. 4.

[illegible]

figure would be a rhombus, built up of two equilateral triangles, equilibrium would be stable, and the k observation agreed within 5 per cent. with the calculation.

How did a gas become luminous, giving a spectrum, not merely scattered light? On the ordinary view, the electrons wriggled about under external shocks, emitting waves; if so, a gas should gradually become more and more luminous. But the luminosity set in suddenly when the force imparted a minimum critical speed to the electron. If the actual ejection of an electron (or its return) were required, luminosity should be impossible without free electrons—*i.e.*, without ionisation and conductivity. But there was, *e.g.*, fluorescence of iodine vapour and of eosin without ionisation and conductivity. Here the q particles (Lecture II.) came in. When one particle was ejected, causing unit change in the value of h (1), the electrons would fall in without being ejected, a new equilibrium would be established, and the energy liberated for new values h_1 and [illegible]

[illegible]

[illegible] bore in its frequency a constant ratio to the energy change, and [illegible] in the lines of a spectrum series. On these arguments, a comparatively small number of q particles could account for the existence of many lines, since the number of possible energy changes varied with the square of the number of q particles. Among the facts in [illegible] jars were inserted in the circuit, and when different parts of the tube [illegible] energy with it.

[illegible]

[illegible] transparent medium was reflected or transmitted. That view was compatible with the lecturer's electric system. Light striking a transparent medium threw the system into forced vibrations of the light period, not of the medium's own period. If the arriving units were of uniform phase, the forced vibrations settled down, and there was no loss of energy; if there were rapid changes of phase, there would be a period of disturbance, before the medium could adjust itself to the changed period, and there would be absorptions of energy. It was thus the medium which exerted a sorting action and made the originally haphazard vibration units appear uniform. On these arguments there should be several equilibrium positions in the atom; if in one atom the electron was further from the core than in another, the former electron would more easily be ejected, and the atom should have the greater refractive index. But we could not separate normal hydrogen into atoms of two kinds; the second abnormal condition might, however, be produced by the very same cause which gave rise to the radiation. The greatest energy and maximum radiation frequency would correspond to the greatest displacement of the electron, when on falling in it approached the core nearest; there should thus be a limit frequency, and the Balmer series of hydrogen, indeed, converged to $\lambda=3{,}646$, where the lines were crowded; as Schumann and Lyman had found hydrogen lines of much smaller λ, between 900 and 800, however, there must be another equilibrium position still nearer the core.

Were these phenomena of the atom possible also in the compound molecule? If we imagined two more electrons in the grouping of Fig. 2, they might, together with the electrons C and D, arrange themselves in one plane at right angles to the paper, so that the third was in front and the fourth behind, and the molecule became an octahedron, in which each electron was linked with two others and further with A and B; that would be a single bond system. The two new electrons might also go, the one close to A, the other close to B (outside the figure, but in its plane), and thus be linked only with these positive cores, each by a double bond. If the electrons could swing round from one position into the other, there would be a change of bondages without ejection of electrons. That might account for colour changes not accompanied by any chemical changes; red mercury iodide turned deeper red and then yellow on heating and resumed its colour on cooling, and some isomerides fluoresced apparently while passing from one modification into the other. The ejection of an electron would also lead to a change in the bonds, and if the bonds of different molecules were similar, we could understand why the ionisation potentials of so many elements and compounds had nearly the same value of 10 volts. Franck and Hertz determined the ionisation potentials of He 20·5, Ne 16 argon. 12, H 11, O 9, N 7·5 volts; Hughes and Dixon* found H_2 10·2, O_2 9·2, N 7·7, [illegible], Hg 10·2, Cl_2 8·2, CO 7·2, NO 9·3, HCl 9·5, CH_4 9·[illegible] and Br, CO_2, C_2H_2, C_2H_4, C_2H_6, all 10 or 9·9. That agreement almost seemed to suggest that the ionisation depended upon [illegible] (H, O), but the low values of CO, N, Cl, &c., could not be explained on these lines; the low values of the strongly [illegible] were also against this assumption.

If the combination of atoms to molecules required the liberation [illegible], the combination should set up [illegible]. That was not so, however. When chlorine and hydrogen [illegible] of HCl and dried) were [illegible] in a beam of light, two electrodes in that [illegible] a trace of conducti[illegible] occasionally the [illegible] there might [illegible] not observed [illegible] united [illegible]

[illegible]

* [illegible] 1917.

electrons and four valencies. He supposed that the atom of any element (not considering hydrogen) contained the nucleus of a kind of helium residue, consisting of 4 + charges held together by two electrons; he further assumed that there was an "inverse" nucleus of 4 more negative charges; these four electrons could not be balanced (second lecture) by 2 + charges, but required 3 or 4 + units; the general structure would be tetrahedral, the electrons being at the corner, and the 3 or 4 + charges inside. On that argument all atomic weights (roughly integers) representing the number of positive charges, should be multiples of 4 plus a remainder, viz., $4p+0$, $4p+3$, $4p+4$ (leaving out the exceptional remainder 1 and 2). In the case of lithium there might be one helium nucleus with 4 positive charges at the centre, 2 electrons embedded in them, and further one inverse nucleus of 4 electrons holding 3 positive charges in equilibrium; to make the atom neutral, one more electron would be required, and this seventh electron would be free on the outer ring or shell, and represent the valency. Carbon would contain 2 helium units (each of 4 + and 2 −), and an inverse nucleus of 4 − and 4 +, giving 12 + charges and 8 −; four of the latter would be in the outer shell and determine the valency. He admitted that the suggested structures were peculiar.

In his sixth (last) lecture Sir Joseph Thomson first referred again to the two elements which were exceptional as to the remainder left when the atomic weight was divided by 4, namely beryllium 9, and nitrogen 14. He had not investigated beryllium. Nitrogen he had submitted to hundreds of positive-rays analyses which depended merely upon the atomic weight, and not upon any chemical properties; nitrogen was very favourable for this test, since its parabolic spectrum fell between those of oxygen and carbon; the resulting value was 14, correct within 1 part in 1,000. That disposed also of the repeatedly raised objection that nitrogen might be a mixture of two isotopes, *i.e.*, elements of identical properties, chemically inseparable, yet differing as to atomic weight. Thus nitrogen (and beryllium as well) seemed to have a special atomic structure—an interesting problem.

When the atomic weights were plotted as ordinates against the atomic numbers, they all fell more or less on one straight line (the odd and even numbers on opposite sides); but the line really consisted of three sections, separated by two gaps, the second section being shifted a little higher up with respect to the first, and the third again shifted. Now there were no elements missing in those gaps. If the elements in the second section (from Ca=40 up to gallium, Ga=69·9) contained two helium residues (electrically neutral), instead of one, the atomic weight would change by 4, but the free electrons and chemical properties would remain unchanged. It was noteworthy that near the first gap were argon (39·9), which chemically did not fit in that place of the periodic table, and potassium, the latter being the only decidedly radio-active element (Campbell) of low atomic weight; the former atomic weight ought to be A=36, not 40. Further, in the first section eight elements made up the short period of recurring similar chemical properties, whilst the long period of the second section consisted of twice eight elements; thus bromine was the 16th element after chlorine, whilst chlorine was eighth after fluorine. The properties might depend also on the arrangement of the positive core, not merely on the electrons. Plotting his atomic numbers N against the square root of the frequency of the characteristic radiation, Moseley had found $N-S=\sqrt{\text{(frequency)}}$, and supposed this S to be approximately constant; in the lecturer's view the slight disturbances of the curves (straight lines) would be explained if the outer rings of electrons and their absolute numbers had also some influence, not only the inner ring. That looked so from the various fluorescence glows (reddish, green, blue, &c.) of different substances under bombardment by soft (slow) cathode rays; in separating the rare earths Crookes had found this glow peculiarly sensitive to slight impurities. The great differences in the absorption spectra of the two didymium (neo and praseo dymium) were likewise noteworthy in this respect.

Sir Joseph finally reverted to the fact that most atomic weights were very nearly, but not quite, integers, being generally slightly smaller, but in four cases (beryllium, magnesium, silicon, chlorine) slightly greater, taking hydrogen H=1 as unit, and not (as chemists do) oxygen O=16, when H=1·008. It had been suggested that chemical combination was accompanied by a slight change in mass; but Landolt and others had failed to establish any change. At Cambridge they had attempted to determine whether the ratio weight/mass was abnormal for radio-active substances; they had made pendulum bobs of radium and uranium, metal or compounds, but had found the ratio constant within 1 : 40,000, and Zeeman quite recently had confirmed these experiments within 1 : 4,000,000. If there were any change they should be in the core and affect the atomic weight and its deviation from the integer value. He had

hence examined chlorine by positive-ray analysis, as chlorine (35·2) exceeded the integer value most; but his analysis confirmed the chemical. If there were a condensation of the particles into the cores of combining atoms, the exceptional position of the four elements mentioned (Be, Mg, Si, Cl) was a critical difficulty. But the energy changes accompanying changes in weight would be enormous. If that change were to move with the velocity of light, we should have to deal with energies of the order of chemical combination. If the atomic weight of hydrogen changed from 1·008 to 1, the energy liberated per gramme would be equivalent to the energy required to raise 10^6 tons by 45m. In the case of chlorine that energy would be stored up in the atom. These considerations might throw light on the problem of gravitation. Hence, it was most desirable to check the atomic weights most carefully—after the war.

Correspondence.

THE STIFFNESS OF PLATE-BUILT TURBO-ROTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: A misconception has on some occasions arisen upon an important point in connection with the stiffness of plate-built rotors assembled without through shafts. This confusion of ideas was again apparent in a Paper recently read before the Institution of Electrical Engineers, and the few remarks upon the matter which I had the opportunity of making during the discussion evdently failed to clear it up. I shall much appreciate it if you will kindly extend the hospitality of your columns for this purpose.

To avoid masking the really simple underlying idea by any jargon of mathematical symbols I content myself in the following with a common-sense illustra ion in preference to a formal demonstration.

The type of rotor under discussion is built up of a number of thick plates rabetted into one another, and held together by four large bolts near the periphery; the plates are solid to the centre, there being no central shaft through them. The question under debate is whether the stiffness of the structure is determined merely by the bolt cross-sectional areas multiplied by the squares of their distances from the centre; or whether the compressive areas of the plates around the bolts are to be included in determining the effective moment of inertia of cross-section for bending effects; and, as a corollary, whether the writer is correct in stating that the range of stress *variation* in the bolts as the rotor revolves, is much lower with the bolts properly tightened than when they are loose. The matter is somewhat akin to the problem of the sharing of a load between two tie rods having different moduli of elasticity (E); the loose rotor has a small effective E in places, while the tight one has everywhere the same value of E as the bolts have. Or, again, one may refer to the somewhat analogous case of the change of tension in cylinder cover studs when steam pressure comes on.

The exaggerated illustration I will take is that of the steel beam of rectangular section shown in Fig. 1. It has two small longitudinal holes drilled symmetrically near the top and bottom surfaces, and through each hole is passed a steel wire anchored at each end face of the beam with suitable devices for putting any desired tension on the wire. As long as all stresses remain within the elastic range, any [illegible] which stretches such a wire by, say, one-tenth of 1 per cent. gives to all intents and purposes the same additional lb. per square inch stress in the wire, whether we start with an initial tension of 1 lb. per square inch or of [illegible]. It gives us one-tenth of 1 per cent. of E, or say 30,000 lb. per square inch additional stress. We may, therefore, determine the stress variation solely by the length variation. If now the holes had not been drilled, the stress in a fibre of the beam at A and at a given cross-section along the length of the beam would have been (My/I), where M is the bending moment at the section in question and I is the moment of inertia of cross-section of the beam. The total extension of this fibre from end to end of the beam would have been (LM_0y/IE), where M_0 is the mean value of M taken over the length of the beam. This will then also be the extension of the small wire in the hole first mentioned. The additional stress, therefore, which is superposed upon the initial wire stress, by reason of the bending moments, is M_0y/I, that is to say, it is the same as the average (over the beam length) of the fibre stress in the same location (A) in the solid beam, this fibre stress being determined by considering the moment of intertia of the total beam cross-section.

Now, let us assume that the beam is relieved of all bending moments, and that these wires are tightened up until they produce a uniform ompressive stress (f) at all beam sections. Having done this let a bending moment be applied to the beam, but such that at no cross-section does it exceed the value (If/d). We then have compressive stress everywhere in the beam material and tension in the wires; and, on account of the linear stress-strain relations the deflection of the beam is the same as though there were no initial stresses. Since the whole beam material is under compression, it will make no difference if we cut it through at any one or more places, duly providing for shear by rabetting. That is to say, in such a beam cut through and held together by tension wires, the additional stress imposed upon the wires when a bending moment is applied is (M_0y/I), as explained above, and where I is the moment of inertia of the whole beam-section rectangle, including the large compressive areas around the wire holes. This result is independent of the cross-se tional area of the small wires.

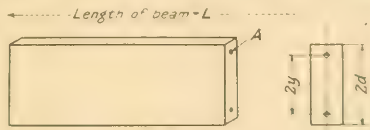

Fig. 1

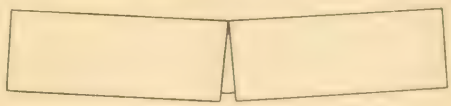

Fig. 2

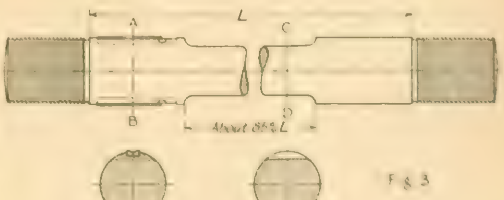

Fig. 3

Also the deflection of the [illegible] part beam is the same as that of the solid one under the same bending moment. On the other hand, were the wires to be so slack that upon applying the bending moment the beam compression vanished at all places except near the top edge (see Fig. 2), the area to be considered in determining the effective moment of inertia of cross-section would be merely the cross-section of the wires themselves and that of the local compression region at the top edge. In this case, too, the additional stress upon the wires imposed by the bending moment would be [illegible] the wires [illegible] initial tension [illegible] upon the [illegible].

In determining the figures for the turbo-rotor case which I gave at the Institution discussion [illegible] per cent. for the longitudinal [illegible]—I did not include all the compressive area, but only that of a limited region around the bolt holes, in order to remain on the conservative side. It should further be pointed out that, while this considerable reduction in the range of stress ensues from tight bolts, the effect is not a gradually progressive one, and therefore [illegible] once the initial bolt tension has attained a

[illegible] sufficient to produce a "tight rotor," the full effect has been obtained.

Finally, where the type of longitudinal bolt referred to at the Institution discussion is used (see Fig. 3), the further refinement can readily be made, if desired, of slightly tapering down the section towards the mid-point of the bolt-length, so that the stress range everywhere is that corresponding to the similarly located fibres of the solid rotor, instead of being uniform throughout the bolt length and equal to the *average* figure for the corresponding fibres.—I am, &c.,

London, March 23. A. B. FIELD.

"PROF. PERRY'S" (?) HARMONIC ANALYSIS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: When an English student has made and explained a useful discovery, he seldom gets anything more than the honour of having done so, and one therefore cannot too strongly denounce a conspiracy to rob him of this, such as now appears to exist in the case of Mr. Wedmore and his method of harmonic analysis.

This method is explained in the "Journal" of the Institution of Electrical Engineers for 1896; and as Prof. Perry had previously invented a method of effecting the same object, he can be excused for not at first having fully recognised the superiority of the new method. But he cannot be excused for having eventually adopted this method in a way that makes it appear to be his own. I have before me a work on practical mathematics by Usherwood and Trimble, published by Macmillan in 1916, with a section devoted to the explanation of Mr. Wedmore's method; but it is headed "Perry's Tabular Method," and there is no mention whatever of Mr. Wedmore. Mr. Trimble may be genuinely under the impression that the method really is Prof. Perry's: but I regret to say that this cannot be the case with Mr. Usherwood, for I have now seen a pamphlet written by him and published by the Board of Education in 1912 which shows that he even then knew this [illegible] Wedmore's method.

Messrs. Macmillan refuse to discuss the matter, and it therefore appears that a great injustice is going to be done to Mr. Wedmore unless some fair-minded editor of a widely-read [illegible] will allow the matter to be dealt with in his columns.—I am, &c.,

Newcastle-on-Tyne, March 23. W. F. DUNTON.

The Control of Large Amounts of Power.

[illegible] which took place [illegible] Institution of Electrical Engineers [illegible] Paper on the above subject. An [illegible] THE ELECTRICIAN of [illegible]

[illegible] had put [illegible] The author [illegible] a higher power [illegible]

it from the machine or machines tied to the section in question." That was extremely interesting, and deserved careful consideration in all inter-connection schemes.

Mr. S. F. WALKER said that the Paper required an immense amount of study. Reactance was going to be a splendid "instrument," He had studied very carefully the report of the Coal Conservation Sub-Committee. The author referred to 100,000 k.v.a., but we might not stop at that. Why not have purely overhead and purely underground bus bar systems receiving current from every possible station in the kingdom and deliver current to everybody who wants it? Why not deal with every source of power available and deliver it all to one system—a system of cable, running north and south, east and west, tapping every source of power? The water-power in the Highlands of Scotland and all the heat that was going to waste in iron works, steel furnaces, gas works, could be harnessed and delivered.

Mr. H. FARADAY PROCTOR said that many people had fallen into an error in construing the interim report of the Coal Conservation Sub-Committee. The report did not suggest that there should be 16 generating stations, only that the country should be divided up into 16 generation areas. There might be half a dozen stations in each of these areas. The report was only issued a month or two ago to the public, but the suggestion for 16 areas was put forward by the Linking-up Committee some 18 months ago. Again Mr. Walker mentioned the utilisation of other sources of power. The report suggested the use of waste heat from blast furnaces, and generating stations in the future would not be merely electric generating stations; they would have, perhaps, gas and all other works for by-products; the only difficulty would be to know which was the by or main product.

Mr. W. NAIRN remarked that so long as the distribution system was sound there was no difficulty in handling on the network the 100,000 k.v.a. which the author took as his typical station output: the difficulties only arising when a fault occurred on the system. The matter of primary importance was to have reliable protective gear installed which would disconnect the fault as speedily as possible, the reactances having only a secondary duty, viz., to stem the rush of current to the fault until the protective gear had done its work. The faults might occur (1) on the main or overhead lines, and (2) on the switchgear or 'bus bars in the sub-stations. Thanks to the valuable research work which was carried on on the North-East coast, there were the Merz-Price and Merz-Hunter protective systems which might be safely left to take charge of faults of the first class, but 'bus bar faults were a more difficult problem. No protective gear available would prevent such faults being thrown back on to the power station overload relays. The author mentioned the use of fixed time limit relays which graded settings, but such relays were useless outside the power station for clearing such faults. It would be interesting to know how the author proposed to install them on, say, a simple ring main. The question of 'bus bar faults was another of the limiting factors in the extension of super-networks. To ensure a reliable supply, it was necessary to divide the network into rings of reasonable capacity not solidly linked together, and if power was to be inter-changed between power stations of large size it should be done through separate trunk feeders and not through the network. The author gave the size of the individual units for a station with 50,000 kw. output, viz., 1 = 50,000 k.v.a. unit, and 3 = 25,000 k.v.a. units, the 50,000 k.v.a. set being used when available. He thought that this would make a most unsatisfactory station, as he did not consider it safe to handle such a large load as 50,000 k.v.a. with only one set running. Not less than three units of suitable size should be used on such a load, and if one dropped out the remaining two units would at least maintain an impaired supply until the spare machine was switched in. The particulars given regarding reactances were most valuable. Whilst their installation in generator circuits and in 'bus bar sections was no doubt justified, the difficulty of pre-determining the current on extensive networks would prevent their extended use in this position. The question of whether the reactance on the generator circuit should be external or internal was a question for the designer of the machine, and as soon as makers ceased attributing breakdowns of generators to faults on the external circuits, so soon would power station engineers be only too pleased to dispense with the external reactance. In conclusion, he would like to ask the author the size in current carrying capacity of the largest three-phase 500 volt automatic oil switch now available.

Mr. [illegible] PEPPER remarked that the author was not favourably disposed to the installation of impedance coils actually in the conductors of the feeders transmitting load under normal conditions. Would he consider it practicable to install the before mentioned impedance coil in the conductors of separate feeders providing they were normally short-circuited with an oil switch, the maximum cut-out of which should be devoid of any time limit, so that in the event of a rush of current due to a fault the oil switch would open immediately, giving the desired checking effect afforded by an impedance coil before the rush of current rose to its maximum? This question depended entirely upon the time limit of the cut-out under the conditions of fault prevailing.

Mr. C. T. ALLAN said he had experienced less trouble with pole lines than with underground cables, and was of opinion that external reactance was of little use because of step-down transformers. The sub-division of switchgear was a very important point, and he approved the tendency of switchgear manufacturers to increase the sub-divisions. Could the author give some idea of the time operation of the old and present types of relays? He would prefer to take impedance out of feeders, and would like to ask whether reactances without iron cores required more room than those containing iron? Current transformers should be as large as possible.

Electric Equipment of Poplar National Kitchen and Restaurant.

Lord Rhondda, the Food Controller, opened the second of London's national kitchens at [illegible] Baths, Roman Road, Poplar, E., on Tuesday, March 26. A feature of the equipment is the use of electrical apparatus for baking, roasting and boiling purposes. The [illegible] bath, which is temporarily boarded over, has been fitted out for a length of about 40 ft. as a kitchen, and the rest of the space, about 100 ft., is provided with tables and chairs, so that food purchased at the kitchen counter can be eaten in comfort on the premises. The Poplar Borough Council electricity department supply energy for the electrical apparatus and have run in two 100 amperes 230 volt services, one on each side of the three-wire system. The cooking equipment has been installed by the Staines Kitchen Equipment Co., Ltd., and comprises both steam and electrical apparatus. Steam is used for four steam boilers, two 20 gallon and two 15 gallon and one six-chamber pudding steamer; the rest of the equipment is electrical, and has been supplied by the Brompton & Kensington Accessories Co., Ltd., of Earl's Court-road, London, S.W. It includes a large pastry oven [illegible] wide by 3 ft. 2 in. deep by 4 ft. 4 in. high, divided into three ovens, each having a loading of 4.5 kw. with six heats per oven; these ovens are used for cooking rice puddings, &c. There are also three large roasting ovens each loaded to 3 kw., and having three-heat control. The boiling plate equipment comprises three B. & K. hotplates of the closed type, each loaded to 1,400 watts with three heat control and six of the open type with similar control, and having a loading of 1,400 watts each. A motor-driven mincer which is operated through gearing and a potato peeling machine, which is driven by belt from the mincer motor, form part of the electrical equipment. A Belling standardised oven of 6 kw. loading and with six heat control is also in use. The kitchen and restaurant was officially inspected and opened by Lord Rhondda on Tuesday, and in the course of his speech, Lord Rhondda referred to the growth of the national kitchen movement. What was being done in Poplar would, he hoped, be also done throughout the country, and his object was to establish kitchens, not only for the working classes but for all classes. The Ministry of Food was prepared to advise local authorities upon the installation of kitchens if information was supplied as to the number of people to be catered for. National kitchens were [illegible] surance; they would be self-supporting and would unquestionably economise food. He expected that during the next three months some 2,000 kitchens would be opened in different parts of the country.

The Poplar kitchen is open from 8 a.m. to 5.30 p.m., and has a capacity for [illegible] 2,100 [illegible] men menu gives an idea of the low charges, but in spite of such popular prices, Mr. Spencer, who has recently been appointed [illegible] as Director of Kitchens, stated that the [illegible] most satisfactory, and showed that a sinking fund equal to the cost of the equipment could be provided [illegible] fish cakes 2d., macaroni cheese 3d., roast beef, half coupon, 4d., potatoes 1d., greens 1d., cornflower mould 1½d., rhubarb ½d., baked rice 1½d. The kitchen [illegible] electrical apparatus was quite [illegible]

Legal Intelligence.

Osram Lamp Litigation.

[illegible]

A Battery Trade Custom.

[illegible]

hand. He was [illegible] they were [illegible] up, but the plaintiff denied.

Judge GRAHAM said defendant should have returned the lot without breaking the seals, and would have to pay as he had not done so. There would be judgment for plaintiff for the full amount claimed, and costs.

Renewal of Patents in Neutral Countries.

At the [illegible] with an [illegible] 1914, by paying or proposing to pay in neutral countries fees for the renewal of patents held by Germans.

Mr. Justice [illegible] real offence, and he was satisfied that Mr. Imray had no intention of benefiting himself at the expense of his country, and did not realise that he was breaking the law. He ordered [illegible] £100, and costs.

Mr. Travers Humphreys said that under Board of Trade licences agents might pay in this country on behalf of Germans the fees necessary for the renewal of patents held by Germans, but payments on behalf of Germans for the renewal of patents in neutral countries were not permitted.

Great Eastern Railway Co. v. Postmaster-General.

At the Surveyors' Institution on Monday Mr. [illegible] trator, commenced the hearing of a claim by the Great Eastern Railway Co. for £33,393 compensation from the Postmaster-General for the taking of subsoil for the Post Office Tube Railway under Liverpool-street station.

Col. Thornton (general manager of the Great Eastern Railway) and others gave evidence for claimants and Mr. H. H. Dalrymple Hay (engineer of the Post Office Railway), for the respondents.

A report of the arguments and evidence [illegible]

Parliamentary Intelligence.

Electrical Training for Discharged Soldiers and Sailors.—In the House of Commons last week Sir A. [illegible] stated, in reply to a question, that the Advisory Committee appointed by the Minister of Labour in conjunction with the Minister of Pensions had under consideration the question of training disabled sailors and soldiers in the electrical engineering trades, and the representatives of the associations and employers and of workpeople had just completed their recommendations in regard to dynamo and motor manufacture and cable manufacture. These proposals would be considered by the two Departments. In the meantime local war pensions committees had been recommended to proceed with schemes of training conditional upon their being brought into line with the recommendations of the Trade Advisory Committee when approved and issued.

Industrial Reconstruction.—In the House of Commons last week Mr. [illegible] asked whether the work of the Ministry of Reconstruction [illegible] recommendations of a definite kind had been made by the Ministry of Reconstruction to the War Cabinet; and whether the work of the Ministry was based upon the continuance of Free Trade, or whether it was based upon the report of the Committee presided over by Lord Balfour of Burleigh on the commercial and industrial policy to be [illegible]

[illegible] frame schemes for tiding the country over the transition period, and [illegible]

Volunteer Notices.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

[illegible]

Officer for the Week.—Capt. W. Hynam.

[illegible]

Monday, April 1.—Commandant's Parade at Waterloo Station 8.45 a.m.

[illegible]

Recruits' Drill, 6.30.

[illegible]

Corps, 2.45–4.45.

[illegible]

Commercial Topics.

Rationing of Electricity and Gas.

The President of the Board of Trade (Sir Albert Stanley) proposes to appoint a Select Committee to inquire into the consumption of coal for gas and electricity, and report at the earliest moment.

Gas and electricity will be restricted to five-sixths of the amount consumed in the corresponding quarter of last year, subject to a minimum allowance below which the consumption need not be reduced. Sir Albert announces new lighting regulations for London. All lights in restaurants dining rooms, &c., are to be extinguished between 10 p.m. and 5 a.m., and no lights are to burn in any theatre, music hall, kinema house or other public place s of amusement between 10.30 p.m. and 1 p.m. All power stations will be rationed and the number of underground trains reduced.

* * * *

Electrical Engineering Developments.

The period of the war has been noteworthy for a belated awakening to the importance of industry as a factor in the life of the nation. The outstanding lesson which Britons are learning to-day is the absolute necessity for organising the industrial resources of the Empire in the interests of the efficiency and security of Imperial trade as a whole.

In the past British manufacturers have been handicapped in competition with their foreign rivals owing to the lack of support given to them by the Government. It would, however, be dangerous if manufacturers trusted only to Government action, which is always slow and generally handicapped by political necessities, but fortunately the situction is fully realised by the leaders in the engineering industry, and to mention only one direction in which steps are being taken, we may cite the important combinations of interests which are being effected by prominent firms.

A notable example of the above is the well-known firm of Dick, Kerr & Co. (Ltd.), who, for many years have had the reputation for enterprise and skill of a high order in connection with their business as civil, mechanical and electrical engineers. In the early days of its existence the company was engaged principally in contracting and in the manufacture of light railway material, which was, and is still, carried on at their general engineering works at Kilmarnock. As contractors on the largest scale for the construction of railways, tramways, waterworks and buildings, they still occupy a leading position, and incidentally it may be mentioned that it was their close connection with British tramway developments which led them to become manufacturers of electrical machinery, and resulted in the establishment of their well-known Preston works. Within the last few months Messrs. Dick, Kerr & Co. have acquired another Preston business, that of the United Electric Car Co., whose works cover some 15 acres, and are equipped to build every class of rolling stock for railways and tramways. In addition to the consolidation of the firm's interest at Preston they have recently acquired control of the old-established engineering business of Willans & Robinson, of Rugby, who have a world-wide reputation in connection with the Willans central valve engine, and have for some years specialised in the manufacture of steam turbines and Diesel engines. Messrs. Willans & Robinson's property at Rugby embraces some 40 acres, and the works' equipment will effectively meet present-day manufacturing requirements in the direction indicated. The businesses above referred to, while retaining separate [illegible] for [illegible] purposes in the hands of Dick, Kerr & Co., with headquarters at their London office in Abchurch-yard, Cannon street, E.C. Within the last few weeks negotiations have been [illegible] Dynamo Mfg. Co., of Bradford, by which a [illegible] which have been manufactured separately by both the companies, shall be manufactured jointly at Bradford. [illegible] upon the advantage [illegible] arrangements, but one [illegible] experience [illegible] available for all, yet [illegible] products for which it is [illegible] of the Dick, Kerr organisation, its extensive home and foreign connections will be available for [illegible] ought to be able to [illegible] be met with after the [illegible]

* * * *

Financial Facilities for the Electrical Trades.

[illegible] Board of Trade Journal of March 14, [illegible] Committee, it is [illegible] for the development the [illegible] manufacturers is perhaps [illegible] of a powerful financial [illegible]

[illegible] Great Britain [illegible] temporary [illegible] cooperation [illegible]

[illegible] public [illegible] with a [illegible] the [illegible] whether at home [illegible] of funds

In Germany organised alliance, offensive and defensive, has been elaborated between manufacture and finance. Banks and manufacturing concerns have common directors, and on the boards of both there sit technical and commercial experts. The German financiers find the money themselves or through their allied groups, and wait till success is shown before they unload on the public. The balance-sheets for 1915 of the Allgemeine Electricitats Gesellschaft, the Siemens-Schuckert Co., and the Bergmann Co., show cash balances of 6¼, 2½ and 1½ millions sterling, respectively, and the Committee consider that these funds are ready for peace projects, and the fact emphasises the necessity for financial assistance being at the disposal of British manufacturers. The Committee is of opinion that the establishment of industrial banks assisted by expert assessors, is essential.

* * * *

The Proposed Empire Trade-mark.

The Commercial Committee of the House of Commons have unanimously decided against the proposal of the British Empire League to create by law a British Empire Trade Mark.

* * * *

The Allocation of Municipal Trading Profits.

A meeting of Manchester Corporation was held on the 27th inst. to consider a report of the Trading Profits Special Committee as to the allocation of trading profits.

It is recommended that in future the Electricity Committee should contribute to the relief of the rates £31,651 per annum (1 per cent. on the capital expenditure), that the Gas Committee should contribute £30,993 (1 per cent. on the capital expenditure) and that the Tramways Committee should contribute £111,891 (5 per cent. on the capital expenditure). The total of the three contributions is £174,535 (less £37,500), or £137,035 net. The members of the Special Committee were not unanimous, as some thought the contributions should be higher. Others thought the payments should be less, and some thought that nothing in aid of the rates should be exacted from the trading committees. The amounts recommended were a compromise.

In submitting the report, the chairman (Mr. Smethurst) said the general principle of grants in aid of rates was sound. Corporations gave to trading departments many privileges for which they were entitled to remuneration. The ratepaye s were the owners of the property ; they found the capital, and were entitled to be compensated for their guarantees and responsibilities. The true test of the soundness of the principle was found in the answer to the question, "Who will bear the loss, if any ?" Moreover, Parliament had expressed approval of the principle. As regards electricity, the small consumer was not affected in the same degree as the gas consumer.

* * * *

Furnace Plant Demands.

The Davis Furnace Co., Luton, reports that during the last couple of months the character of the demand for furnace plant has totally changed.

Whereas for the last two months of 1917 about 85 per cent. of their orders were for crucible furnaces for metal melting, for the first two months in this year the position has been reversed, and now at least 80 per cent. of the orders are for furnaces of the oven type, principally for heating steel billets and plant for tool-making purposes. Increased pressure upon contractors by certain Government departments is accountable for the change.

Electricity Supply.

Extensions.

Chesterfield. The new plant at the electricity works, comprising a 2,000 kw. turbo-alternator, Le Blanc set condenser and cooling tower, switchgear, &c., was formally started on Wednesday. The total capacity of the generating plant is now 4,200 kw.

Rhyl. On the advice of the borough electrical engineer (Mr. E. H. Wright), the Council has decided to install a storage battery of sufficient capacity to enable the generating plant to be shut down during light loads.

Swansea. The Board of Trade has extended by one year from Apr. 28, 1918, the time limited by Swansea Corporation Light Railways (Extension) Order, 1914, for purchase of lands and completion of certain works.

General.

Gillingham. The Council recently rejected by 12 votes to 6 the Stock and Stores Sub-Committee's recommendation to purchase another Diesel oil engine for the electricity works, at an estimated cost of £12,000.

It was reported that the Kent Electric Power Co. had been unable to undertake to supply the additional electrical energy required by the Council.

Huddersfield. In submitting the Corporation's annual accounts and estimates last week, Ald. Woodhead stated that in spite of the

cost of repairs and the ever-increasing war bonuses the Tramways Committee was easily able to afford 3d. in the pound in relief of the general rate, or a penny less than last year, and the Electricity Committee had been able to vote 1d. in the pound out of the earnings of the undertaking.

Newcastle-on-Tyne.—The Corporation decided last week to protest to the Treasury against granting permission for the issue of debentures by the Tees Power Station Co., and to instruct the Parliamentary Committee to take any further possible steps in opposition to the Company's project.

Newquay.—The Newquay Electric Light & Power Co. is applying to the Board of Trade for authority for a variation of their provisional order so as to authorise the following maximum prices for current: Up to 12 units, 10s., and for each unit over 12 10d.

Private Bill Legislation.—The Clyde Valley Electrical Power Co. is promoting a provisional order to authorise an increase in the share capital to enable the company to borrow further moneys, to enter into agreements for the purposes of their existing Acts and Order, &c.

Edinburgh Corporation are applying for a provisional order authorising the construction of 16 new tramway routes in the Edinburgh district, the use of the overhead or rail-less trolley systems of traction, &c.

Restrictions in the Use of Gas and Electricity.—All communications on the subject of the restrictions in the use of gas and electricity should be addressed to Mr. Garnham Roper, C.B., Assistant Secretary, Board of Trade, 7, Whitehall-gardens, London, S.W. 1.

Electric Traction.

Ilford.—Owing to the difficulty of obtaining team labour the Works Committee proposes to purchase two Edison electric accumulator lorries, chassis type, of 3½ tons capacity, and two steel lorry bodies.

Miscellaneous.

Aluminium Data.—In anticipation of extended trade in countries in which the metric system is exclusively used, the British Aluminium Co. has prepared a metric edition of "Aluminium: Facts and Figures."

The opportunity has been taken of incorporating additional data on various forms of aluminium and of considerably amplifying the "Hints on the working of Aluminium." The loose-leaf principle has been adhered to in the publication, to allow of the addition or substitution of new leaves, as occasion arises. The present set of data is in English and Spanish, and should prove extremely useful to engineers and others interested in the use of aluminium.

Electrical Trades' Benevolent Institution.—The proceeds of the concert recently organised at Cardiff have been swelled by a donation of 25 guineas from the General Electric Co., making the total amount by which the Institution has benefited £49 5s.

Tenders Invited and Accepted.

Turbo-Alternator, Surface Condenser, &c.

The Electricity Committee of [illegible] Corporation invite tenders for the supply, delivery and erection of one [illegible]-kw. turbo-alternator, surface condenser and appliances. Specifications and form of tender from the [illegible] electrical engineer, Mr. J. Alex. Bell, to whom tenders must be delivered by noon April [illegible].

Static Transformers.

MANCHESTER Electricity Committee require tenders by 10 a.m. April 2 for the supply and erection of [illegible] three-phase static transformers. Specifications, &c., from Mr. F. E. Hughes, Town Hall, Manchester.

[illegible]

[illegible]

[illegible]

[illegible]

WOLVERHAMPTON.—The Council has accepted the following tenders:— [illegible] Motor (Ltd.), [illegible]; Gibbons Bros., [illegible] plant, £1,363, plus 15 per cent. for contingencies; Chloride Electrical Storage Co., maintenance of storage battery; Callender's Cable & Construction Co., annual supply of rubber-covered cable.

Appointments Vacant and Filled.

An assistant lecturer attached to the engineering department is required by the City of Hull Education Committee for the day and evening departments of the Municipal Technical College. Salary £175, rising to £250, plus 5s. per hour for evening classes. Forms of application, &c., from Dr. J. T. Riley, Director of Education, Albion-street, Hull. *See advertisement.*

Salford Corporation require two switchboard and substation attendants. Salary 50s. to 65s., inclusive of bonus. Applications to the Borough Electrical Engineer. *See advertisement.*

An electrician is wanted for d.c. station on S.W. Coast. Salary, including bonus, £150. *See advertisement.*

Three draughtsmen, accustomed to transformer work, are required in the Manchester district. *See advertisement.*

Applications are invited for the position of operation superintendent in the traffic branch of the London County Council Tramways Department. Salary from £600 to £800. Forms of application from the Clerk of the Council, Spring Gardens, S.W. 1. Applications by 1 p.m. April 15.

An electric supply company with seaside stations in Devon and Cornwall advertise for an assistant or charge engineer or fitter driver for small d.c. plant. Salary, including bonus, £150.

Liverpool Tramways Committee recommend the City Council to appoint Mr. J. S. D. Moffet (general manager of the Belfast tramways) as deputy manager of the Liverpool tramways.

Mr. R. C. Harpur (mains superintendent) has been appointed borough electrical engineer, and Mr. E. W. Smith (works superintendent) has been appointed chief assistant electrical engineer at Dover.

Mr. A. Mackrill, of Hull, has been appointed commercial manager to the Borough Electrical Engineer of Stoke-on-Trent.

Mr. Archer Smith, manager of the Post Office telephone service in the Belfast district, has been appointed to a similar position at Newcastle-on-Tyne.

Business Items.

Messrs. Babcock & Wilcox have made an arrangement with certain Spanish interests for the creation of a large constructional company in Spain, and one of the terms of the agreement is that the company will purchase in the United Kingdom all imported materials, plant, &c., provided equal conditions of quality and price are obtainable.

The General Vehicle Co. has been compelled to remove into temporary premises at 4, Southampton-row, London, W.C. 1.

The Renex Electric Lamp Co. (Ltd.), of Harrow-road, Willesden Junction, London, N.W. 10, have issued their revised catalogue, giving prices of refilling old and worn-out electric lamps.

The London address of the Kingston Gas & Oil Engine Co. (Ltd.) is now Albion House, 59-61, New Oxford-street, W.C. 1, their offices at Imperial House, Kingsway, having been taken for Government purposes. Their telephone number (Gerrard 1286) has been retained.

Plant for Sale.—[illegible]

[illegible]

Prices of Cables and Wires.—Messrs. W. T. Henley's Telegraph Works Co., [illegible]

[illegible]

Z. Drawn Wire Lamps.—[illegible]

X-Ray Literature.—We have received from Messrs. Watson & Sons (Electro-Medical), Ltd., of [illegible], London, a copy of No. [illegible]

[illegible] instructive matter on valves, X-ray plates, &c.

"The Welding Test."—We have received from Messrs Barimar (Ltd.) an illustrated and well-printed booklet with the above title. [illegible] have built up an almost entirely new business [illegible] of fractured parts of machinery, and the booklet deals with the subject in simple language. It shows how the firm has brought back into commission more than 20,000 British derelict machines now engaged on National Service. Many of the delicate processes by which complete metal fusion is brought about were practically German preserves in pre-war days. Copies of the booklet can be obtained from Messrs. Barimar (Ltd.), 10, Poland-street, Oxford-street, London, W. 1.

Liquidations, &c.

A meeting to receive an account of the winding up of Michael [illegible] & Co. Ltd. will be held at 42 and 43, Tower-chambers, Moorgate, London, E.C.2, on April 18.

The Monometer Mfg. Co. (Ltd.) is being wound up voluntarily. Mr. H. T. C. S. Ledsam, 16, Waterloo-street, Birmingham, and Mr. G. G. Poppleton, 26, Corporation-street, Birmingham, have been appointed liquidators.

A supplemental dividend of 5s. 1½d. is payable at the O.R.'s, 1, Priory-road, Dudley, to creditors of Geo. Edwd. Hipkins, electrical engineer, 48, Wolverhampton-street, Dudley.

Companies' Meetings and Reports.

City of London Electric Lighting Co. (Ltd.)

The 28th ordinary general meeting was held on Wednesday, March 20, Mr. J. B. BRAITHWAITE occupying the chair.

Mr. J. CECIL BULL (Joint Managing Director) having read the notice convening the meeting and the auditors' report, and the report of the Directors and the accounts having been taken as read,

The CHAIRMAN said: Gentlemen, in moving the adoption of the report and accounts there is very little, I think, for me to detain you with on this occasion. We have had a difficult year owing to the various circumstances which have beset us in different ways. We have had the Summer Time Act, the increased war bonus and labour diffiulties of [illegible], although I am happy to say that, as far as our own staff are concerned, our relations with them throughout the year has been most harmonious, and we have had no dispute of any kind with them. The units sold during the year increased by 714,000. Capital account again shows very small expenditure—only £5,839. 9s. 5d. That is due to the fact that we have not had the need to erect any additional plant recently. We have written off £29,372. 9s. 10d.—principally off reciprocating engines and generators which we no longer require—so that there is a net reduction in our capital account of about £23,000. A satisfactory feature this year is that we find ourselves able to revert to the normal amount of £50,000 which we have been in the habit of putting to depreciation year by year for a long period. Revenue shows an increase of £18,250 and expenses an increase of £10,389, of which about [illegible] net increase in revenue of £7,861. An item in the balance sheet which deserves mention is the charge against [illegible] £330 [illegible] 2d. That is the result of an effort which Mr. Frank Bailey has made—I think with a considerable [illegible] in the difficult times we had [illegible]

[illegible] instead of £34,000 last year. [illegible] now been going on [illegible] we have put aside for [illegible] expended on capital [illegible]

[illegible]

[illegible] The Coal Controller, in seeking to cut down the coal consumption of the electric supply undertakings, is tending to increase the consumption of coal rather than to diminish it, because every ton we burn, whether the current it produces is used for lighting, heating or power, is doing work which otherwise would only be done by a very much greater expenditure of coal. I am afraid his attempt to secure economy of coal by cutting down the electric supply will only have one result, and that will be to injure the trade of the country, because, if people are to have power to carry on the business of the country, the cheapest power they can have is electric power, and if he insists on cutting that down obviously one of two things must happen—either they must go back to steam plant and burn a much larger amount of coal, or else they will have to shut down altogether I will therefore conclude by moving that the report and accounts be adopted.

The DEPUTY-CHAIRMAN (Mr. Frederick W. Reynolds) seconded the resolution.

Mr. HEDGES said the chairman's statement was so good that it seemed to him that the Coal Controller would be much obliged to him for giving him information to enable him to bring about an economy for the country, also other electric companies which are affected in the same way. In view of the statement that everything was to be closed down at 9.30, would it not affect the company's receipts and profits, and therefore did it not become them to prepare for it in the way of economy? He noticed that in 1914 the dividend was 9 per cent. and this year 8 per cent. The net revenue in 1914 was £164,000, whereas at the present time it was only £141,000, or £23,000 less. He thought it was a question whether they should not turn their attention to amalgamation with either the Charing Cross, the Westminster, or some other company, instead of competing one against the other. An amalgamation would cut down expenses and be much more economical, and it would be beneficial to the companies.

The CHAIRMAN said with regard to the proposal to close down places of entertainment at 9.30, it was difficult to know what the effect of that may be: but it would not affect them in the City, or very little. With regard to the decrease in our net revenue since the war began, he was rather surprised that any shareholder should be ignorant of the cause of that. The total increase in expenses on coal alone was £40,000 a year compared with pre-war prices. Whenever the war ended they may hope to see the dividend resume its normal figure. As to the question of amalgamation, in the City they have no other single company that was competing with them. The only company that had been introduced into the City is the City Co. Department of the Charing Cross Co. It was impossible to amalgamate with that particular branch of that company, as they had a particular purchase clause and all sorts of regulations which rendered amalgamation absolutely impossible, even if the City company wished to do it, and they did not wish to take on the West End business. There is a further reason which was conclusive—that under their own provisional orders they are debarred from entering into association with any other company or firm supplying current outside the City. He then put the resolution for the adoption of the report and accounts, which was carried. The dividends as set out in the report were also approved.

Mr. Frederick William Reynolds and Major the Marquis of Winchester were then re-elected directors of the company, and Messrs. W. H. Pannell & Co. were re-elected auditors.

A vote of thanks was accorded the chairman, the staff and the management.

Kensington & Knightsbridge Electric Lighting Co. (Ltd.)

The ordinary general meeting was held on the 21st inst., Col. R. E. [illegible] (Chairman), presiding.

The SECRETARY (Mr. G. S. Britton) having read the notice convening the meeting and the auditors' report,

The CHAIRMAN said: Gentlemen, at last year's meeting I pointed out to you that during the war years 1914, 1915 and 1916 there had been a progressive falling off in our output of units sold, but early in 1917 there were signs that the tide had turned. That this forecast has been confirmed to the extent of nearly half a million units. Revenue has increased by about £10,500—from £64,037 up to £74,493. Unoccupied premises in the district have decreased from 451 to 386, which is a gain of 65 houses, yielding us revenue. On account of the increased cost of fuel, increase in wages and the allowances to our workmen and to all our staff which have been made under various awards, and the extra work entailed by generating a considerable number of units at Chevalier station and that we have purchased from the joint station at our Wood-lane works, [illegible] has increased the total cost of generating from £25,444 to £31,[illegible], an increase of about £6,041. Distribution costs have slightly [illegible] and rates and taxes have increased largely. We have been able to provide an increased sum for depreciation, but we hope to put aside still larger sums when conditions are more favourable. Balance of profit has increased from £11,573 to £13,224, or £1,651, which will enable us to add 1 per cent. to the dividend and to increase the amount we carry forward. We obtain our fuel with difficulty, and the quality is very poor, which increases the labour charges, as our men have to handle larger quantities of coal, which produces more ash when burnt. Again, the scarcity of material for maintenance, and the almost impossibility of getting any of our repairs carried out at manufacturers' works, has entailed on us the whole duty of repairs, which adds to our expenses. The supply we give for heating and cooking has again increased considerably. This is probably due to the difficulties that our customers have in obtaining coal for domestic use, which has caused many consumers to install electric heating apparatus in their premises.

The showroom and sale department has been very fully occupied, and the sales have nearly doubled. In fact, more orders have been received than the company can carry out with its reduced staff, so that about 45 per cent. of this work has been handed over to local contractors. During the present year we shall do very well if we keep up to the present mark of profit earning, for we have to look forward to further difficulties in carrying on business—labour charges and cost of material—and it is hinted that restrictions in the use of electricity will be ordered, that the daylight saving hours will be longer, and that the Government requests to consumers to use less electricity in their homes and businesses will have some effect. Feeling this, we think it necessary to again increase the charges by a further 10 per cent., which will make a total advance on pre-war prices of 20 per cent. I now move that the report and accounts be adopted.

Mr. C. C. WYLLIE seconded the motion, and it was carried unanimously, and the dividends as set out in the report were approved.

The CHAIRMAN then requested the sanction of the shareholders to the grant of an annuity of £100 during his life to Mr. Geo. Hopkinson, who had served the company for many years and was now entirely incapacitated by illness from earning any income. Mr. Hopkinson, who was a partner in a London bank, joined the board of the company in 1890. In the company's early days Mr. Hopkinson worked very hard for them, and obtained a great deal of money for them. He was sure every member of the Board would agree with him as to the high value they put on Mr. Hopkinson's advice as a skilled financial man. He moved that a pension of £100 per annum during the term of his life be granted to Mr. George Hopkinson.

Mr. C. C. WYLLIE seconded the motion and it was carried unanimously.

Col. Crompton was re-elected as a director and Messrs. Price, Waterhouse & Co. were re-elected auditors.

Charing Cross, West End & City Electricity Supply Co. Ltd.

The ordinary general meeting was held on the 21st inst., under the presidency of Mr. WILLIAM FRANCIS FLADGATE, M.V.O.

The SECRETARY (Mr. [illegible]) having read the notice convening the meeting and the auditors' reports,

The CHAIRMAN said: I will say a few words to you upon this, the fourth [illegible] of our meeting since the outbreak of the war. The effect which has been felt in every industry and in every sphere of life [illegible] the preceding years our difficulties were great; in this last year they are infinitely greater. Although sale of energy increased, the increase in expenses has been correspondingly greater. The question of coal affects us in two ways, first, in a great increase in price, and secondly in the decrease of quality, making it necessary for us to consume a greater quantity for a smaller amount of energy. [illegible] in our Bow station, and the cost has increased from £[illegible] to £87,767. Although we do not consume coal in our West End stations, the increase in its price has been the main cause of the [illegible]. Sales of current has increased from £144,510 to £158,409 and cost of fuel increased by no less than £18,500. For practical purposes every item of expenditure is increased [illegible]

[illegible]

12½ per cent. on wages will directly increase the price of almost every material we have to buy. The Government have appointed more than one Committee to report on the various trade questions which may arise after the war, and naturally this has included the position of the electric lighting and gas industries. No final report has yet been issued, but there have been interim reports, one in particular dealing with the coal supply. We shall most carefully watch the position and endeavour to guard your interests so far as we possibly can. Incidentally it is suggested that there shall be new authorities and larger areas, and the erection of super-stations is advocated. The London companies are, more or less, blamed for not having supplied energy at a cheaper rate and so made it more available for general use. Against this latter charge I have more than once protested, and again protest, as I believe it to be unfair. Whatever may be decided as regards other districts, the London area should, in my opinion, be dealt with as an individual one. It has been my personal endeavour for many years to bring about an amalgamation of the London companies, as I believe they are fully competent, under proper conditions, to carry out the whole work for the London area, and would do so better, and more economically, than any other possible combination. Further, they should not be blamed for the present position of the industry. So long ago as the year 1908, if Parliament had given its sanction to the whole of the Bill promoted by this and the majority of the other London companies, we should have been able to deal with the whole of the London district, and to do so with success. If, as I believe, an amalgamation of the London companies would be for their benefit, I am quite sure it would be for the benefit of the London County Council, who have the ultimate right of purchase. I cannot close without expressing some words of thanks to our staff, both electrical and clerical, for their services during the past year. Nor can I forget those who are doing their duty in our country's service. Fortunately during the past year we have lost no more lives. I am asked by my co-director, Col. Laurie, to express his regret for not being present. He is doing his duty in France, and therefore his services have for some time been only occasionally given to us. I now move that the report and accounts be received and adopted.

The MANAGING DIRECTOR (Mr. John M. Gatti) seconded the resolution and it was unanimously adopted.

The dividends as set out in the report were approved, and Mr. W. F. Fladgate and Mr. J. M. Gatti were re-elected as directors.

Messrs. O. R. Johnson & Son were re-elected auditors, and a hearty vote of thanks to the chairman and directors was carried.

BOURNEMOUTH & POOLE ELECTRICITY SUPPLY CO. (LTD.).—At the recent meeting the chairman (Mr. A. H. Sanderson) said that the strain of war conditions had become more burdensome than ever owing to the [illegible] and meter rentals amounted to £72,283, against £63,543 for 1916. Their working expenses had increased by [illegible] cost of coal and other fuel (£5,202) and rates, taxes and insurance (£2,224). The net result was that they were carrying to net revenue account [illegible] applications for electric current showed an increase of 712 kw., which, [illegible]

BRISTOL TRAMWAYS & CARRIAGE CO. [illegible]

BROMPTON & KENSINGTON ELECTRICITY SUPPLY CO. (LTD.). [illegible]

CLEVELAND & DURHAM ELECTRIC POWER (LTD.). [illegible]

[illegible] renewals account, net profit was £7,575, and £9,825 was brought forward, making £17,400. The directors recommend a dividend of 2 per cent. on preference shares, that £1,000 be applied in reduction of expenses of debenture issue, and £9,726 is carried forward. Connections to the system at Dec 31 were 83,737 H.P., an increase of 2,268 H.P. The offer to exchange shares made by the Newcastle-upon-Tyne Electric Supply Co. was largely taken advantage of by shareholders.

HASTINGS & DISTRICT ELECTRIC TRAMWAYS CO. (LTD.)—The report states that the accounts show an available profit balance of £12,972. The directors recommend payment of dividend of 6 per cent. on the preference shares for the year 1917 (£4,800), that £2,500 be placed to depreciation, £4,810 to reduction of suspense account, and £861 carried forward.

LONDON UNITED TRAMWAYS (LTD.)—The debenture holders committee, in an interim report, states that it has made considerable progress with the representatives of the shareholders in agreeing a scheme for the reorganisation of the capital. The arrangements are, however, dependent upon the passing into law of a Bill now before Parliament, and until this is assured it is not possible to submit any definite proposals. The tramways urgently require a large expenditure on renewals and repairs, and the committee has agreed to recommend that the moneys coming from the London County Council, amounting to nearly a quarter of a million sterling, and other funds accumulated in the receivership should be applied to the physical habilitation of the system, and has also agreed to the conversion of part of the existing debenture stock into preference shares. With regard to the proposed reorganisation of the capital, it is not possible at present to say more than that it provides for a great reduction of the present share capital, and the division of the existing debenture stock of £1,650,000 into equal moieties of 4 per cent. debenture stock and 5 per cent. preference shares non-cumulative for five years, but with priority of capital.

MACKAY COMPANIES.—The report of the Mackay Companies for the year ended Feb. 1 last states that income from investments in other companies was $4,519,364 and dividends paid on the Mackay Companies shares $4,425,198. Operating and other expenses, including Federal income-tax were $89,058, and balance carried forward is $5,108. The assets comprise investments $92,417,778 and cash $881,074, totalling $93,298,852, while liabilities consist of preferred shares issued $50,000,000 common shares issued $41,380,400, and surplus $1,918,452.

NEWCASTLE-ON-TYNE ELECTRIC SUPPLY CO. (LTD.)—At this Company's meeting last week the chairman (Mr. J. H. Armstrong) said in consequence of effects of the war the directors had reluctantly come to the conclusion that it was necessary to increase the prices charged for electrical energy. In the case of lighting the increase was 10 per cent., and for heating it was 15 per cent., and negotiations were in hand with regard to an increase in prices charged under long-term contracts. He believed he was right in saying that they were the last big electrical undertaking to take this step. There had been an increase in the cost of everything, including plant, repairs, stores, and lastly, but not least, wages. Referring to the report of the sub-committee on electric power supply, he said there was no part of the kingdom where the manufacturer during the war had had his demands met with less trouble and delay [illegible]. The area controlled by the Company was now some [illegible] and extended from the north of Blyth to the Cleveland iron mines in the south. Throughout this area they were dealing [illegible] power supply, as they had intimate working relationships with the local authorities, with the exception of Sunderland, [illegible]. Referring to a pamphlet written by a [illegible] in agreement with that shareholder on one [illegible] that it would be a great [illegible] of the Newcastle [illegible] companies would be amalgamated into one.

NORTH METROPOLITAN ELECTRICAL POWER DISTRIBUTION CO. (LTD.) [illegible] 1917 was £2[illegible], an increase of £2,640 over that of [illegible] amount to £1,772. [illegible] brought forward, and deduct [illegible] £1,000 for renewals, [illegible] that £1,000 be placed [illegible] restrictions [illegible] credit balance [illegible] The number of units [illegible] 1916 [illegible] of approx. [illegible]

[illegible] ELECTRIC CO. (LTD.) [illegible] 191[illegible] [illegible] £1,000 for debenture [illegible]

[illegible] DEVELOPMENT CO. (LTD.)—The profit for the year [illegible] 10 per cent. [illegible] has been placed to [illegible]

[illegible] TRAMWAYS & TRAMROADS CO.—[illegible]

like £11,500 more than a year ago, and the greater part of that increase had been made in the latter half of the year. The receipts were still increasing, and the increase was not due to any increase in ordinary fares. The increased income was distributed over three heads—ordinary, holiday and workmen traffic. The larger amount of the increase (about 85 per cent.) was under ordinary traffic, and was due to the fact that railway traffic had been very much reduced and was more expensive, and also because there was no facilities for river traffic. Workmen traffic had contributed £1,000 out of the increased revenue of £11,500. The directors proposed to pay a dividend of 5 per cent. on the preference shares, and to pay a dividend at the rate of 5 per cent. per annum on the ordinary shares. Last year it was 3 per cent.

WASTE HEAT AND GAS ELECTRICAL GENERATING STATIONS (LTD.) The profit for the year ended Jan. 31 was £40,080 (against £40,731 in 1917), and after placing £11,500 to reserve, and adding £19,411 brought forward, the amount available is £45,511. The directors recommend that £5,000 be transferred to experimental expense account, and that a dividend be declared at the rate of 8 per cent. for the year, leaving to be carried forward £19,911. Considerable delay has been experienced in the completion of the new generating plant at Weardale power station; the whole of the plant is, however, now on site and is undergoing preliminary trials. Arrangements have been made for carrying out certain experimental wotk jointly with the Newcastle-upon-Tyne Electric Supply Co., which it is hoped will further the Company's interests. It has not yet been possible to make any progress in connection with the proposed station at Horden, but the necessary sanction to proceed with the work having now been received, contracts are being prepared, and constructional work will proceed as possible.

YORKSHIRE (WEST RIDING) ELECTRIC TRAMWAYS CO.—The report of the Yorkshire (West Riding) Electric Tramways Co. for 1917 shows net income, after providing for debenture interest and making provision for deferred repairs, of £32,521; and £15,952 was brought forward, making £48,474. A dividend of 6 per cent., less tax, on preference shares has been declared, £5,000 applied to purchase of funded preferential dividend certificates, £12,456 placed to renewals, depreciation, reserve fund in lieu of accident insurance, and general reserve fund, £20,609 being carried forward.

City Notes.

MADRAS ELECTRIC TRAMWAYS (1904) (LTD.)—A dividend of 3 per cent. on the preference shares has been declared, making 6 per cent. for the year.

MIRRLESS-WATSON CO. (LTD.)—The directors recommend payment of a dividend of 10 per cent. and a bonus of 2½ per cent., less tax. For the previous year a dividend of 10 per cent., less tax, was paid.

O. C. HAWKES (LTD.)—A final dividend at the rate of 7 per cent. per annum, making 6 per cent. for the year, has been declared.

P. & W. MACLELLAN (LTD.)—The directors have declared an interim dividend of 6 per cent. on the preference and ordinary shares, and recommend a surplus dividend of 6 per cent. on both. For 1916 the dividend on each class was 10 per cent.

WEMYSS & DISTRICT TRAMWAYS CO.—In addition to the 3 per cent. already paid on the ordinary shares, the directors now propose to pay a further 1½ per cent. The past year's receipts reached the record figure of £17,043.

W. T. HENLEY'S TELEGRAPH WORKS CO. (LTD.)—Subject to audit the directors recommend a final dividend on the ordinary shares of 10 per cent., less tax, making 15 per cent. for the year, and also a binus of 10s. per share' less tax.

The Round Table.

By "kVA."

Good luck to our men and engineers who are holding up and killing the Hun in France. (In spite of his 70 mile gun!)

* * * *

Event of the Week. Lord Rhondda opens an electric national kitchen in Poplar without getting a shock!

* * * *

Electro-Harmonic Society members may breathe again: the 9.30 closing order becomes 10.30, and there should be concerts as usual next season.

* * * *

Thirty-Seven Years Ago.

[From The Electrician, March 26, 1881.]

Still They Come. "L'Electricité" announces yet another paper, rather hybrid as regards its title, which is "Le Gaz et l'Electricité." This is going into the enemy's camp with a vengeance. Our contemporary also says that it is probable the exhibition will see another electrical journal launched.

Patience on Her Monument. The Edinburgh correspondent of the "Gas Journal" wonders whether the Philosophical Society of Glasgow has become so enamoured of the electric light as to lose sight of the public duty which they have to perform, namely, of publishing the awards of the committees on the various articles shown at the exhibition of gas apparatus in October last.

THE ELECTRICIAN:

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CONTENTS.

NOTICE.

On and after April 6th to-morrow the Editorial and Advertisement Offices of "The Electrician" will be closed on Saturdays.

Notes.

Nominations to the I.E.E. Council.

The following nominations have been issued by the present Council and are subject to additional nominations by the members:—

President.
C. H. Wordingham.

Vice-Presidents.
(Two Vacancies.)

[illegible]

Honorary Treasurer.
(One Vacancy.)

[illegible]

Ordinary Members of Council.
(Five Vacancies.)

[illegible]

Sir R. A. Hadfield, Bart., F.R.S.

[illegible]

Associate Members of Council.
(One Vacancy.)

[illegible]

The names printed in italics are the nominations for the vacancies which will occur. [illegible]

The New Nominations.

It will be seen that Mr. C. H. Wordingham continues in office. [illegible]

members in detail, for they are all well known to our readers; but it is of some interest to consider the extent to which the various sections of the industry are represented. Taking the members who remain in office, together with the new nominees, it will be seen that manufacturing accounts for seven members, the electricity supply industry coming second with five members. It would seem that these two sections are claiming, perhaps, a little too much in the way of representation. It must be remembered, however, that manufacturers, who should certainly be represented in considerable strength, have very varied interests, and should therefore claim greater consideration than station engineers. It is noticeable that the manufacturing group includes three representatives of the cable industry, and that there is only one nominee (who may or may not be elected) as representative of the heavy branches of electrical engineering. This seems to be insufficient. There is also, of course, the business of contracting; but, as this class of work is generally undertaken also by our manufacturers, the position may be considered satisfactory merely from this point of view. Apart from this aspect, there appears to us to be a lack of balance in connection with electric traction, as Mr. Devonshire is the sole representative of electric tramways, and there is no representative of electric railways, which should be a very important branch of the electrical industry in the near future. Nor is there any representative of electrical engineering in mining. It is, no doubt, somewhat natural that the smaller branches of the industry, though certainly very important, such as wireless telegraphy and electrical instruments, should be unrepresented; but it is equally desirable that these branches should not be forgotten in the general distribution. We are inclined to think that it would be a good plan for the Council to adopt a regular scheme of [illegible] vote should not be forgotten.

Induction Generators with Phase Advancers.

[illegible] Prof. Kapp [illegible] the protective devices and switchgear of large generating [illegible] proposal raises many important questions, not only of technical [illegible] discussion renders a serious and complete examination of the [illegible] load, whilst the reactive component of the *total* load, along with [illegible] Prof. Kapp [illegible]

generators with phase advancers. He contends that the switchgear and protective devices would be simpler and less costly with the latter arrangement, while the phase-advancers would enable the induction machines to take their fair share of the reactive component of the load. The argument is illustrated by reference to a design for a 12,000 kw. turbo-induction generator, but in such a machine many other points would have to be dealt with besides those discussed by the speaker. To mention but a few of these, we must consider the reliability of the phase advancer compared with that of the exciter, the use of governors with induction generators, the mechanical difficulties arising from the small air gap of the induction machine, the need of a laminated rotor, the loss in the end bells due to induced currents of slip frequency, and so on. These are all serious matters, and would demand most careful attention by the designer and manufacturer. Thus, the need of a 3 mm. air-gap for a 12,000 kw. machine running at 1,500 revs. per min. does not look at all promising. Where it is merely a question of supplying reactive current, it is probable that in the future greater demands will be made on the rotary converter rather than on the induction generator; and whilst the adoption of the latter machine to simplify switchgear, &c., may prove feasible, it would not be wise to be optimistic before the proposition has been seriously investigated.

Technical Teachers and the Institutions.

To the unsophisticated the teaching profession appears to offer certain monetary and other advantages to those who have had a technical training and who have afterwards spent a year or two in the works. Most education authorities insist on technical training and "workshop" experience as qualifications for a teacher of engineering. To those having the one and the other, the smaller authorities (encouraged by the Board of Education) usually offer about £120 per annum and make the offer more attractive by specifying about 25 hours' teaching per week and absurdly long holidays. To the man who is working from 48 to 54 hours per week, and who seldom gets more than 10 days holiday in the year, the offer is a highly attractive one, particularly since he will [illegible] for shorter hours (on paper). Long before [illegible] can lay claim to the title of electrical engineer they become part of the education muddle of the country, and the Education Authority is quiet because it is aware that the labour is inexpensive and dumb. We have little sympathy with those who become technical teachers before they are properly trained, and who find after a few years [illegible] into a profession possessing no [illegible] openly [illegible] But we have sympathy for those whose misfortune it is to receive their technical training [illegible] Till recently, at any rate, it has been a relatively easy matter [illegible] to join the Institution of Electrical Engineers. The present Institution [illegible] qualifications, and [illegible] to the teacher than [illegible] that, under existing conditions, some engineering degrees can [illegible]

a trained and experienced engineer before he can join the Institution of Electrical Engineers. The immediate effect of this would be to deter those who take too rosy a view of the £120 per year and long holidays from leaving the works. Moreover, there would be an appreciable decrease in the number of A.M.I.E.E.s who lower the standard of the engineering profession by working for a smaller wage than that paid by many an employer to his typist. If associate membership in the engineering institutions means anything more than the privilege of putting a long string of letters after one's name by paying an annual subscription, it certainly should mean that the associate member is worth a living wage in the profession.

The Five-Day Week.

As will be seen by an announcement on another page, our offices will in future be closed on Saturdays, thus giving our staff a complete day's holiday every week. From this it will be seen that the proprietors have joined the progressive movement in favour of a shorter week's work. There has been a good deal of discussion on the desirability of the five-day week as compared with the usual five and a half-day week. In many respects the old half-day is somewhat inefficient. Provided that the necessary work can be carried out in five days instead of five and a half days, there is, no doubt, much to be said in favour of the shorter week, as it gives time for relaxation and leads to greater freshness of mind and body, enabling the work of the following week to be carried through with greater vigour. As to whether this shorter week can be adopted by manufacturers remains to be proved. We know of at least one case in which the question was put to the employees, on the understanding that the output would not be reduced through this loss of time; and, owing to the strong feeling in favour of the shorter week, this was adopted, at least for the summer months, and we understand that the results were entirely satisfactory. In these days of changing ideas and of attempts to obtain higher efficiency and shorter hours, the five-day week merits careful consideration.

Technical Students and the War.—We observe in "Industrial Management" another instance of the intelligent use in connection with the war of students undergoing technical training. The United States Civil Service Commission is endeavouring to relieve the dearth of ship draughtsmen by recommending to the heads of colleges and technical schools that senior students in engineering courses be given intensive training in naval architecture during the coming spring, with a view to making them available for employment as ship draughtsmen.

Electrical Power Engineers' Association.—West Yorkshire Branch.—A meeting was held on Wednesday, the 27th instant, at the Y.M.C.A. Buildings, Leeds, to form the local branch of the Electrical Power Engineers' Association.

Mr. [illegible], of Morley, took the chair, and the following officers were appointed:—

Hon. Branch Secretary, Mr. P. Furness. *Hon. Branch Treasurer*, [illegible]. *Committee*, Messrs. R. C. Atkinson, A. R. Chaytor, [illegible], E. Morgan, P. Morrel, P. W. Penty, E. Priest, [illegible], J. F. Stott, H. W. Snow, P. J. Todd, F. Wilkinson, H. F. Wadsworth. The Committee were instructed to elect a chairman for the branch from their members. Application forms for membership can be obtained from any of the above officials, and should be forwarded to the branch secretary (Mr. P. Furness, 6, Ash Grove, Earlsheaton).

Anti-Shock Aerials for Ships' Wireless.—According to "The Telegraph and Telephone Journal," an invention by Mr. S. Hall has been accepted by the Patent Office which reduces to a minimum the risk of wireless aerials on vessels being broken and the wireless apparatus thus put out of action when a ship becomes mined or torpedoed. The invention is stated to be simple and inexpensive, and utilises one or more long extension springs specially constructed and fitted at each

end of the present aerials, these springs automatically extending and contracting to allow the aerial to lengthen or shorten to take up the varying distances between the top of the masts when they spring out of position through an explosion. These springs do away with the present necessity of lowering the aerial when a ship is being loaded, as they allow for the vibration of the masts caused by working the derricks, and their use would in some cases save the aerial being blown away by shell fire.

A Useful Time-Recording Device for Factories.—An ingenious time-recording device, which not only stamps the time consumed in work on a card, but also enables corresponding wage values to be charted, is described in "Industrial Management." The operation of the instrument, which is termed the "Costimeter," consists in placing a card in the slot and pressing the lever. The timing device may be arranged for any desired interval from one minute upwards; the customary length of interval is one-tenth of an hour, or six minutes. Each instrument is provided with an eight-day clock, or can be arranged for electrical control from a master clock. The workman upon arriving at the factory in the morning inserts his daily card and presses the lever, which records the time. Thereafter during the day he inserts the card again at the completion of each job. The right-hand lower corner of the card is cut off at an angle, which operates a safety lever, and makes it impossible to enter the card except in the right way. Both card and wage chart must be designed for the firm using them. The time clerk reads the time taken from each job and determines its equivalent in money by placing the card on the wage chart and making a direct reading.

Prevention of Scale in Boilers.—The war has stimulated the study of all sources of loss in heating processes, which inevitably lead to waste of fuel. An article by Mr. S. B. Applebaum in the "Electrical World" lays special stress on the use of water-softening ingredients in boilers, with a view to checking the formation of scale. A hard coating of scale only ¼ in. thick, such as may easily form after a few months' use of bad water, and is not unknown in boilers of electric light plants, may have a marked prejudicial effect on the consumption of fuel. By the prevention of scale, he states, 5 to 20 per cent. of the total fuel may often be saved—a matter of importance in cases where boilers have to be hard pushed at the peak of the load. In addition there is the saving in repairs, which in locomotive boilers has been repeatedly found to be a considerable item, in some cases 5 per cent. The actual gain in fuel, repairs, and lessened cost of boiler cleaning is given by the author in an actual example as \$2½ per horse-power per year. Actual figures will naturally vary according to the hardness of the water and other factors, [illegible] the installation of water softening plant [illegible] the [illegible] scale [illegible]

Association of British Electrical Engineers: Electricity Supply Section.—A preliminary Committee has been considering the desirability of forming an Association of Electrical Engineers, Electricity Supply Section. [illegible]

[illegible]

tricity supply industry, but it is hoped that similar sections may be formed for those engaged in other branches of the electrical industries of Great Britain, each with its own Council which will be represented on a Grand Council; this will focus the activities of all engineers engaged in the electrical industries of the United Kingdom. The Association will be in no sense a Trade Union, but will be constructed rather on the lines of the existing professional associations, such as, for instance, the British Medical Association.

The proposal to form this new Association was recently discussed by the Council of the Institution of Electrical Engineers, who have appointed a special vice-presidents' Committee to meet the members of the Preliminary Committee, referred to above, and have agreed to call together mass meetings of professional and technical men engaged in the business of electricity supply throughout the country. Such meetings are to be called both in London and at the local sections. At these meetings the project will be fully discussed and a permanent Executive will be appointed, charged with the duty of giving effect to the proposed formation of the Association.

Obituary.

R. W. Blackwell.—We regret to record the death of Mr. Robert W. Blackwell on the 28th ult., at the age of 59. In our next issue we hope to give an account of the work, much of which was of a pioneering character, on which Mr. Blackwell was actively engaged since the early days of the electrical industry.

Death on Active Service.—The death in action of Private Robert Aspinall (L.N.L. Regiment), previously reported missing, is reported officially. He was formerly employed by Messrs. Dick, Kerr & Co., of Preston.

Personal.

Mr. F. J. S. Hoskens, manager of the Darwen tramways, has tendered his resignation.

War Honours.—Lieut. (Acting Capt. and Adjutant) V. C. Russell (Suffolk Regiment), younger son of Mr. Stuart A. Russell, works manager of the India Rubber Co., Silvertown, has been awarded a bar to the Military Cross. He was awarded the Military Cross in November last, and previous to that had been twice mentioned in despatches. Lieut. Russell has been wounded twice.

War Casualties.—The following casualties are reported:—

Pte. H. [illegible], of the India Rubber Co., has been missing since Oct. 26, 1917.

Corp. A. [illegible], formerly a Nelson tramway employee, is a prisoner of war in Germany.

Arrangements for the Week.

MONDAY, April 8th.

[illegible]

TUESDAY, April 9th.

[illegible] ture I.)

[illegible]

WEDNESDAY, April 10th.

[illegible] ture II.)

THURSDAY, April 11th.

[illegible]

Electric Winding Engines.*

By JOHN F. PERRY.

Summary.—The author describes in general terms the chief systems of electric winding, and discusses their merits as compared with steam methods. Eight alternative schemes are presented. The distribution of energy losses and working and initial costs in each case are analysed by the aid of diagrams and their relative advantages summarised.

The Paper deals with several phases of the winding problem, divisible into sections as follows:—

1. Under this section is given a brief description of the principal features of the more common systems of electric winding.
2. In this section a set of winding conditions is outlined, and particulars given for several different schemes designed to meet the conditions stated.
3. This gives a comparison of the scheme described from the point of view of operation, when working under the conditions set out.
4. Gives particulars as to initial and working cost.
5. Conclusion.

1. General Description of the More Common Systems of Electric Winding.

One of the most important items in a mine installation is the hoist or winder. The one object sought in any winding scheme is to raise the coal or ore, as the case may be, as cheaply and efficiently as possible.

Systems of Electric Winding.—Systems of electric winding may be roughly classified as follows:—

1. Alternating-current motor-geared or direct-coupled to the drum.

1*a*. Alternating-current motor-geared or direct-coupled and equalised by the Westinghouse equaliser system.

2. Direct-current motor direct-coupled to drum with Ward Leonard control.

2*a*. Direct-current motor direct-coupled to drum with Ward-Leonard control, and equalised by means of a flywheel on the M.G. set.

1. *Alternating-current Motor-geared, or Direct-coupled to the Drum.* This is by far the simplest and cheapest system, and consists of an induction motor, driving through gears, or direct-coupled on to the drum shaft, the control being done rheostatically by a special liquid controller.

1*a*. *Alternating-current Westinghouse Equalised.*—This is similar to the alternating-current geared system, but equalised by the use of a rotary converter connected to the alternating-current line, supplying the induction motor of the winder; its direct-current end is connected to a flywheel set, consisting of a direct-current motor and flywheel.

This system has a great many points in its favour. As the flywheel is driven by a direct current motor, the slip can be somewhat extended without undue loss in efficiency; hence a given equalising effect may be obtained from a smaller wheel. Also the same equaliser can supply more than one winder, and when light loads are being raised, the set may be shut down. However, it does not possess the benefits of the Ward Leonard system in the matter of control.

2. *Direct-current Ward Leonard.*—In this system, the drum is usually direct coupled to a direct current motor, which is supplied with current by a motor generator set, consisting (where the main supply of current is alternating current) of an induction motor, coupled to a direct current generator. Where equalisation is required the set has a flywheel, which, when equalisation is not required, is disconnected. The most usual arrangement is for the set to be in the following order: Induction motor, flywheel, direct current generator, exciter. The generator and winding motor are connected together permanently, and the control is effected by a variable [illegible] the field of the generator.

[illegible]

(only about 4 per cent.) unless this slip is increased. To attain this object a slip regulator is installed. In the case of a winding scheme, we need only consider the automatic regulator. This consists of a torque motor connected through series transformers across the line supplying the induction motor of the Ward Leonard set.

In practice it is usual to set the regulator at a point about 20 or 25 per cent. above the average line of the winding diagram, allowing a drop in speed of from 10 to 15 per cent.

2. General Description of the Schemes to be Compared.

Numerous Papers have been written in the past giving actual tests on steam and electric winders. There exists in this country a strong feeling that the electric winder is only suitable for the smaller pits, and cannot compete with steam when large outputs have to be extracted from deep shafts. This is quite a mistaken idea. Let us take a case which by common consent puts the electric winder at a disadvantage. Assuming the following conditions:—

Depth	3,000 ft.
Net load	6·75 tons.
Weight of cage and chain	8 tons 10 cwt.
Total weight of tubs	67·5 cwt.
Size of rope	2·06 in. diam.
Weight of rope	64·8 lb./fathom.
Static S.F.	8
Drum diam. (*see* each individual case)	
Output	334 tons per hour.
Decking time	15 sec. throughout.

Accelerating and retarding turns kept constant throughout.

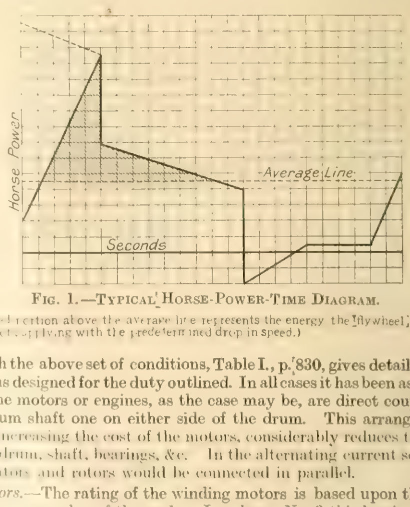


Fig. 1.—Typical Horse-Power-Time Diagram.

(Shaded portion above the average line represents the energy the flywheel must be capable of supplying with the predetermined drop in speed.)

With the above set of conditions, Table I., p. 830, gives details of the systems designed for the duty outlined. In all cases it has been assumed that the motors or engines, as the case may be, are direct coupled to the drum shaft one on either side of the drum. This arrangement, while increasing the cost of the motors, considerably reduces the cost of the drum, shaft, bearings, &c. In the alternating current schemes the stators and rotors would be connected in parallel.

Motors.—The rating of the winding motors is based upon the root mean square value of the cycle. In scheme No. 3 this has increased to 2,000 H.P., due to the inefficient diagram given by the plain drum.

Braking.—The braking necessary in all the alternating current schemes would be done by means of reverse current. The stator windings of the motors would be reversed near the end of each cycle, and sufficient current applied in a reverse direction to exert the necessary negative torque to bring the winder to rest.

Drums.—The small diameter of the drum in schemes Nos. 1, 4 and 5 has been fixed at 75 times the rope diameter, and the large diameter determined from the following formula:—

Large diameter = [illegible] Weight of 1 length of rope + net load / Weight of 1 cage and chain

Schemes Nos. 2, 3, 6, 7 and 8 have a plain cylindrical drum, the diameter being 80 times that of the rope, a ratio which has become [illegible] for plain drums.

Control.—In all the alternating current schemes the controller [illegible] of the liquid type, consisting of a tank having a number of suspended electrodes connected to the slip-rings of the induction motor. A motor pump circulates [illegible] solution through the tank, and

the winding motor is started by means of a sliding weir, which alters the level of the solution in the tank, thereby submerging the electrodes. The rate of acceleration is fixed by the respective capacities of the tank and pump. The stator current is reversed at the end of each wind by means of high-tension contactors, assuming that motors of this size would be operated from a high-voltage alternating-current supply. With the Ward Leonard schemes the control would be effected by means of a special rheostat in the generator field.

3. Comparison of Various Schemes from the Point of View of Operation.

In the original Paper the author presents diagrams showing respectively the allocation of losses due to friction, &c., the net work being calculated from the formula :—

$$\frac{\text{Net load} \times \text{depth of shaft}}{550} \text{ horse-power-seconds.}$$

The losses are considerably affected by the system of cage guides used, but are usually taken as 17 per cent. of the net load. Other losses occur in the hoist motor, in the controller and in various auxiliaries (pump motor for solution in controller, compressor motor for air brakes, transformers, &c.) Horse-power time diagrams for the various schemes, of which Diagram 1 is typical, are also presented.

Scheme 4 (steam engines) is discussed in detail, as follows:

Here, for the sake of comparison, the actual amount of steam taken by the engine in doing the wind has been converted into kilowatt-hours. The quantity of steam per wind may be considerably increased by bad driving of the engine, whereas in any [illegible]

Steam Available for Turbine.—Allowing 10 per cent. for wetness =say, 45,000 lb. available. Steam consumption of mixed pressure turbine full-load 32 lb. per kilowatt-hour $\frac{45,000}{32}=1,400$ kw. Required 2,000 kw. ; 600 kw. required to be made up by live steam, for which consumption on turbine is 20 lb./kw.-hour. Live steam required $600 \times 20 = 12,000$ lb. of steam per hour extra.

Total Steam Capacity of Boilers.—$51,000 + 12,000 = 63,000 + 7,000$ for contingencies and to give extra storage for peaks $= 70,000$ lb.

It will be seen later that there is very little to choose between this and a complete electric scheme, the actual saving in the particular case under investigation being only about £221 per annum.

Scheme 5 (Ward Leonard) is then considered, and the author remarks:—

In the Ward Leonard system the control is effected by a rheostat in the generator field, by which the voltage applied to the winding motor may be raised from zero to a maximum in either direction. The torque given out by the motor is proportional to the magnetic flux in the air gap, and the ampere-turns on the armature. The field being constant, the current in the armature, as in the case of the alternating-current motor, is proportional to the torque, but the input to the motor will be proportional to the product of the voltage and armature current at any instant, or to make it directly comparable with the alternating-current system, the input is proportional to the torque and speed at any instant, as the voltage is proportional to the speed.

In the case of the Ward Leonard system of control [illegible]

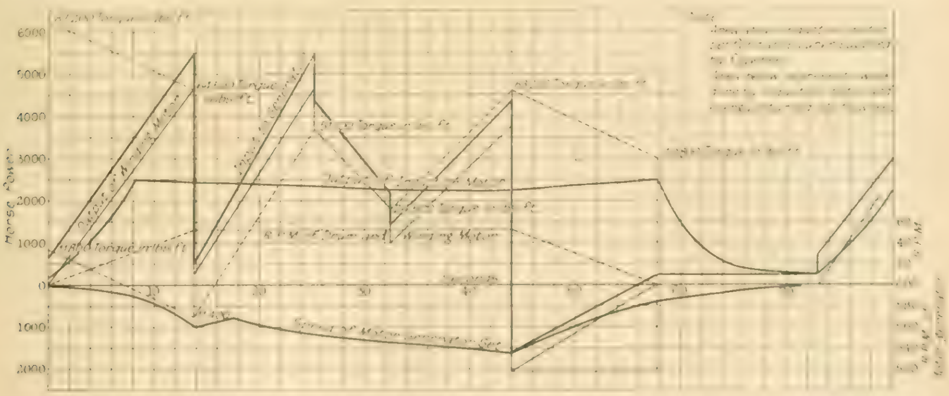


Diagram 1. Schemes [illegible] Horse-power Time Diagram [illegible]

[illegible]

Table I.—*Particulars of Winding System.*

Scheme No.	System.	Motors.	Type of drum.	Diameter of drum.	Speed of drum.	System of control.	Motor-generator set. Size of generators.	Size of induction motors.	Weight of flywheel.	Synchronous speed of set.
		H.P.			R.P.M.		Kw.	H.P.	Tons.	R.P.M.
1	A.C. with cylindro-conical drum	2-1,500	Cylindro-conical.	12′ 6″ to 30′	52·1	A.C.	...	...	...	...
2	A.C. with plain drum and tail rope	2-1,500	Cylindrical.	13′ 9″	84·9	A.C.	...	...	...	...
3	A.C. with plain drum	2-2,000	Cylindrical.	13′ 9″	84·9	A.C.	...	...	...	...
4	Particulars of steam engine given below.									
5	Ward Leonard with cylindro-conical drum	2-1,500	Cylindro-conical.	12′ 6″ to 30′	52·1	Ward Leonard.	2-1,200	2,200	30	600
6	Ward Leonard, with plain drum and tail rope	2-1,500	Cylindrical.	13′ 9″	84·9	Ward Leonard.	2-1,250	2,200	30	600
7	Ward Leonard, with plain drum	2-2,000	Cylindrical.	13′ 9″	84·9	Ward Leonard.	2-1,600	2,500	30	600
8	Ward Leonard, with plain drum unequalised	2-2,000	Cylindrical.	13′ 9″	84·9	Ward Leonard.	2-1,600	3,750	...	600

Engine Particulars.—Cylinders 44 in. diameter, stroke 78 in., speed 52·1 revs. per min., steam pressure 130 lb. per square inch at stop valve, drop valve gear. As in the electrical schemes, the engines would be coupled one on each side of shaft. Drum diameter, 12 ft. 6 in. to 30 ft.

Table II.

Name of pit.	Depth, in feet.	Output per hour-ton.	Net load.	Weight of skip.	Max. rope speed.	Winding rope diam.	Tail rope diam.	Drum diam.	Motor.	System of control.
		(2,000 lb.)	lb.	lb.	ft./min.	in.	in.	ft.	H.P.	
City deep....................	3,210	157·5	9,000	8,000	3,500	19/16	19/16	11	1,600	A.C.
Village Deep	4,200	152·0	10,600	7,000	3,500	19/16	$1\frac{3}{8}$	11	1,600	A.C.
Brakpan	3,800	180·0	10,000	6,000	3,500	$1\frac{1}{4}$	$1\frac{1}{4}$	11	1,450	Ward Leonard.
Village Deep (Turf shaft)	4,093	150·0	10,000	7,000	3,500	$1\frac{1}{4}$	...	12	1,600	A.C.

All the above winders were put into commission in 1911, and have given entire satisfaction. For test results on Village Deep (Turf Shaft) see Table III. below.

Table III.

Eddy-current brake.	Units per trip for auxiliaries. Solution pump.	Air-brake motor.	Circulator pump.	Contactor magnets.	Total	Units per ton raised.	Shaft units.	Overall efficiency.
0·163	0·139	0·197	0·054	0·061	0·614	4·48	3·46	77 per cent.

Section 4.—Comparison of Costs.

On this basis the author presents in the original Paper detailed costs of the various schemes, which may be summarised as follows:—

	Initial cost.		Standing charges per annum
Scheme No. 1	£23,000	......	£2,560
Scheme No. 2	14,000	......	1,640
Scheme No. 3	16,000	......	1,840
Scheme No. 4	10,000	......	1,729
Scheme No. 5	37,000	......	4,100
Scheme No. 6	37,000	......	4,100
Scheme No. 7	37,000	......	4,100
Scheme No. 8	37,000	......	4,100

Section 5.—Conclusions.

Having reviewed the performance of the various systems when working under the stated conditions, we will separate them [illegible] to be drawn. In all [illegible] alternating current [illegible] Rheostatic losses [illegible] schemes 1, 2, 3 vary with the [illegible] [illegible]

In Table II. [illegible] tion in South Africa. In Table III. [illegible] [illegible]

[illegible]

Scheme No. 3 is very inefficient indeed, resulting in raising the R.M.S. value of the motor to 2,000 H.P. With an alternating-current drive on a deep shaft this system could not be tolerated.

Leaving the exhaust steam scheme for the time being, we come to the Ward Leonard equipments in schemes 5, 6, 7 and 8. There is a slight increase in the overall efficiency in the case of scheme No. 6, and a further increase in scheme No. 7. This is due to the fact that in all the Ward Leonard schemes the motor generator losses are practically the same; rheostatic losses at the start and finish have disappeared.

Further, it will be observed on referring to the initial costs of schemes No. 5, 6, 7 and 8 that the total cost of the equipments remain the same, although the sizes alter (*see* Table I.). This is explained by the fact that although the motors in schemes No. 6, 7 and 8 have more overload to do at the start and finish, their increased speed renders them considerably cheaper. This money, however, is not all net gain, as it has to be spent again in the generators.

With regard to scheme No. 4 there is so little in its favour that any colliery would do well to carefully consider the question before adopting it. There are no doubt cases where, due to special conditions, it would be more economical than a complete electrification, but at the present time when the centralisation of power is imminent it is a step in the wrong direction.

In a colliery district a great economy could be effected by the various colliery companies contributing capital and erecting a central power station at the most convenient spot in the locality, instead of each company generating its own power, often at great inconvenience due to local conditions at the individual colliery.

In the event of centralisation of power on a national scale, the site of [illegible] power stations would undoubtedly be near the [illegible] resolve itself into an extension of the collieries cen- [illegible]. With alternating current equipment [illegible] to reduce the peaks at the start and finish, but [illegible] the interest on the money spent to accom- [illegible] equalisation only is required, then the Westinghouse equaliser system merits consideration, but where delicate control is of first importance, then Ward Leonard equipments are at present the best solution.

Elementary Principles of Continuous-Current Armature Winding.

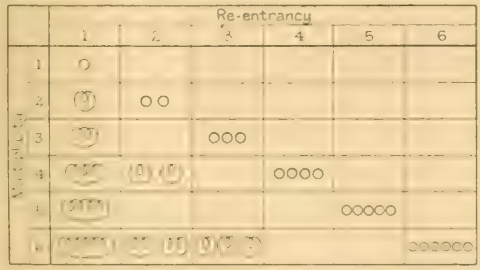
By F. M. DENTON, A.C.G.I.

(*Continued from page* 810.)

Summary.—Continuous-current armature windings are first classified, the nature of the various classes of winding is then explained, and special terms used are defined. The derivation of the usual winding rules is developed by a simple method based upon an understanding of the ordinary Gramme ring. The rules derived apply to multiplex windings as well as to simplex. The use of multiplex windings is discussed, and reasons are given for the avoidance of their use. The simple theory of equalising connections is explained and rules are derived for the application of such connections. Chord winding is explained, followed by the use of interpolated commutator segments, and, finally, special consideration is given to the question of the number of slots that should be used for a given winding. taking into account the inductance of the parallel paths. The article concludes with a schedule of winding rules.

SYMBOLS USED TO DESIGNATE THE VARIOUS WINDINGS.

The adjoining table gives the symbols generally used for the various windings. They are almost self-explanatory, the total number of loops in the symbol (the big outer loop being counted as well as the inner loops, so that, for instance the



symbol in column 2 row 1 [illegible] the multiplicity, whilst the number of independent sections in the symbol tells the re-entrancy.

CHOICE OF TYPE OF WINDING.

The power output and the speed usually determine the number of poles to be employed, and the maximum possible number of positive or of negative brushes is one-half the number of poles. The current output of the machine determines whether or not the maximum possible number of brushes must be used, for it is advisable, in order to have a brush holder pin of moderate dimensions (ensuring [illegible] brush contact and freedom from vibration) and a brush of moderate thickness, to limit the current per brush-holder pin to [illegible].

Thus the type of winding to be used for a [illegible] machine may often be determined simply by the current output required, those of not more than [illegible] amperes output employing a simplex wave winding, with but two [illegible], and those of higher current output using a simplex lap, having, of course, [illegible] poles.

When the current output is greater than [illegible] the [illegible] to use a multiplex winding.

A simplex wave [illegible] two paths through the armature irrespective of the number of poles (p).

A simplex lap [illegible] p paths.

A multiplex wave [illegible] multiple of two paths.

A multiplex lap [illegible] multiple of p paths.

The advantages and disadvantages of multiplex windings, both lap and wave, will be discussed later. Modern practice [illegible] windings, though [illegible] current output. [illegible] speaking [illegible] multiplex windings are used.

EFFECT OF RE-ENTRANCY.

It has been mentioned that multiplex windings differing only in re-entrancy are electrically equivalent. Inspection of the cell diagrams for two such windings makes this evident. Fig. 11 is the cell diagram for a two-pole lap (or "p"-pole wave) duplex singly re-entrant winding, whilst Fig. 12 is that for the corresponding doubly re-entrant winding. Before the brushes are put upon the windings Fig. 11 represents four opposing groups of cells in series, and Fig. 12 represents two independent circuits, each consisting of two opposing groups of cells in series. When, however, the brushes are in position the two diagrams become identical, each representing four groups of cells paralleled between two brushes.

DEFINITIONS.

Before giving the rules for the laying out of armature windings of the various types which have just been discussed, an explanation must be given of some special terms which will be used.

FIG. 11.

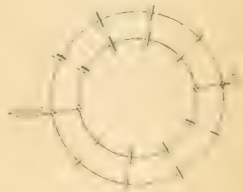


FIG. 12.

Definition of the "Coil" or Bar.—In practice it is usual to speak of the "coils" of a winding. One coil of a lap and a wave-winding respectively are shown in Figs. 13 and 14. A "coil" consists of one or more "turns" in series with one another. In all the following discussion the actual number of turns in a coil will be left out of consideration, since this in no wise affects the winding diagram. Each coil will be said to

FIG. 13.

FIG. 14.

[illegible]

Definition of [illegible] Winding [illegible].—[illegible]

around the periphery of the armature. They will be numbered consecutively, the interval between two consecutive bars being called a "space." Distance between two bars will be measured in "spaces." Thus, the distance between bars 1 2 is one space, or between 2 and 11 is 9 spaces. When an end connection joins, say, bar No. 3 to bar No. 30 it bridges over 27 spaces. This would be expressed by saying that the "winding pitch" is 27. Frequently it happens that the end connections at the two ends of the armature bridge over different numbers of spaces. In this case distinction is made by speaking of "front pitch" and "back pitch," the front of the armature being understood to mean the commutator end.

In deriving the winding rules the following symbols will be used :—

- z=the total number of armature bars (the term "bar" being synonymous with "coil side").
- y_f=the front winding pitch in spaces.
- y_b=the back winding pitch.
- $y=(y_f+y_b)/2$=the arithmetical average of the front and back winding pitches.
- p=the number of poles.
- a=the number of parallel paths through the winding.
- m=the multiplicity (the total number of loops in the complete symbol for the winding).
- r=the re-entrancy (the number of separate and distinct sections in the armature winding).
- $x=m/r$=the number of "plexes." That is to say x is the number of loops in the symbol for each re-entrant section of the winding. Thus the winding whose symbol is shown in column 3 row 6 in the table of symbols would be said to have two "plexes"; it is a sextuplex trebly re-entrant winding, and the symbol for each re-entrant section has *two* loops.

[Note.—Unfortunately the terms "multiplicity" and "re-entrancy" have been used by various authorities in different ways. Prof. S. P. Thompson uses the word "re-entrancy" to mean what is here called "plexity" (m/r), and by multiplicity understands what is here called "re-entrancy."]

Winding Rules.

A winding rule applicable to every closed coil drum winding [illegible] *the total number of bars must be even.* The truth of this rule is almost obvious. Every armature [illegible] of similar coils, and as each coil [illegible] bars the total number of bars is twice the [illegible] even.

[illegible] Lap Winding. [illegible] the derivation of a [illegible] ring winding. Each [illegible] two bars, one lying on the outer and [illegible] periphery of the core. There are thus [illegible] The conversion to the drum-type consists in laying each internal bar between two consecutive external bars. Thus, each "space" of the ring winding [illegible] will form two spaces on the [illegible] represents an [illegible] so that [illegible] drum wind[illegible] space, that is [illegible] The back end connection [illegible] And in general [illegible] whole number [illegible] forms [illegible] Also [illegible] by [illegible] front pitch is odd the back must [illegible]

[illegible]

[illegible]

[illegible] differ by 2.

[illegible]

possible the condition in which both sides of a coil lie at certain moments in one and the same polar region and generate opposing E.M.F.s. An exception to this rule occurs in the case of "chord windings," which will be explained later.

Rules for a Multiplex Multiply Re-entrant Lap Winding, in which the multiplicity is equal to the re-entrancy ($m=r$).—Such a winding consists of m ($=r$) separate and distinct lap windings having their bars spaced alternately upon the same armature (*see* Fig. 5). The interval between two consecutive bars of one of these m windings will form m spaces, and the rules for such a winding will be :—

$z=m$ times an even number—that is, z/m=an even number.

y_f and y_b must each be odd, and they must differ by $2m$.

In developing the multiplex lap from the ring winding by stretching out the conductors there are two methods available. Each re-entrant section of the ring may be developed into a drum, and the several re-entrant sections then interleaved with one another, or the complete multiplex ring winding may have its idle turns stretched out so that it becomes, at one operation, a multiplex lap. The former method leads to the condition not that y_f and y_b must both be odd, but that each must be m times an odd number, whilst the second method demands that, whatever be the value of m, both y_f and y^b must be odd.

The latter method is to be preferred, since, in practice, for simplicity of mechanical construction, windings are laid in the slots in an even number of layers (almost invariably two), and this demands that the sides of a given coil shall be, not in the same, but in consecutive layers in the slots. Each coil must, therefore, embrace an even number of bars and an odd number of spaces—that is to say, both y_f and y_b must be odd.

Rules for a Multiplex Lap Winding in which m and r are not equal.—The pitch of a ring winding measures the distance through which the winding advances for each turn (just as the pitch of a screw measures the distance the screw advances per turn). If the periphery be exactly divisible by the pitch the winding closes after one tour around the armature. For such a winding the multiplicity is equal to the re-entrancy ($m=r$). If, however, the periphery be not divisible by the pitch the winding will not close naturally after one tour; the end of that turn which most nearly coincides with the beginning of the tour will either fall short of or overstep it. If it fails to join by just half the pitch a second tour will exactly suffice to make the winding join up naturally (*see* Fig. 6). So soon as the winding closes (*re-enters* itself) one *re-entrant* section is said to have been completed. In general the winding will close as soon as the number of turns completed covers exactly some multiple of the periphery. In other words, a re-entrant section will be completed as soon as a whole number of complete ring pitches has covered an exact multiple of the armature periphery. But each ring pitch is m spaces and the periphery is z spaces, and so the number of tours in each re-entrant section is the smallest number whose product with z makes a multiple of m. If this number be called x, then x is the number of tours in each re-entrant section and is such that $x \times z = N \times m$, where N is a whole number, and xz is the lowest common multiple of z and m.

Now every symmetrical winding either consists of one section only (in which case it is a singly re-entrant winding) or of several sections all exactly alike, the number of which gives the re-entrancy, and, by definition, plexity × re-entrancy = multiplicity [illegible] m, or [illegible] $m \div$(L.C.M. of z and m)/z [illegible] L.C.M. of z and m.

[illegible] L.C.M. of m and [illegible] G.C.F. of m and z, since, [illegible] G.C.F. of m and [illegible] L.C.M. of m and z.

Hence for a multiplex *ring* winding, the re-entrancy is equal to the greatest common factor of z and m.

The corresponding *drum* windings will have twice as many bars as the ring, [illegible] drum = 2 ring, or, z ring = z drum/2 — and we have for a lap-wound drum :—

$$r = \text{G.C.F. of } z/2 \text{ and } m.$$

Ring windings in which the pitch is greater than one pole pitch may be converted into wave wound drum windings, but among the number of such windings that are mechanically possible only a limited number are suitable electrically. The rules for such windings will be given later.

Ring windings in which the pitch is less than one pole pitch may be converted into lap-wound drum windings. For these the rules have just been derived, that—

z must be even,
y_f and y_b must each be odd,
y_f and y_b must differ by $2m$,
r is the G.C.F. of $z/2$ and m.

Rules for Wave Windings.—The wave winding is the development of a ring winding for which the pitch is about one double-pole pitch. At first thought it would seem that the rules derived

FIG. 15.

for a drum winding developed from a ring would apply equally well to both the lap and wave windings, since these differ from each other only in the magnitude of the pitch of the ring from which they are developed. This is true as regards the mere mechanical problem of laying out a symmetrical winding, but electrical considerations make it necessary to choose from among the mechanically possible wave windings those only which comply with certain electrical conditions peculiar to the wave type. An instance will make this necessity clear. Consider a 12 pole ring winding having 120 bars. Fig. 15 shows such a winding. For simplicity a few only of the bars and end connections have been drawn. A ring winding pitch of 20 has been chosen. Beginning at bar No. 1 the winding proceeds to bar 21, thence to 41, 61, 81, 101 and back to 1, thus closing at the end of one tour. One tour completes one re-entrant section of the winding, and there are 20 such sections in all. The cell diagram for the first tour of this winding is shown in Fig. 16, a series of six cells short circuited. The remaining 19 tours have similar cell diagrams. Such a winding therefore though mechanically possible and symmetrical is of no use electrically. A winding which is good electrically must have a cell diagram in which no short circuiting occurs, that is to say, no circulating currents will be set up. In each "plex" of the diagram there should be equal numbers of clockwise and counter-clockwise cells. This condition demands that the bars of each "plex" of the ring winding shall be half of them under N poles and the others under S poles. That this shall be the case for every position of the armature during its rotation it is necessary that the bars of each "plex" shall be distributed over a whole number of double pole pitches exactly.

Applying this rule to the 12 pole armature just discussed it is seen that the first "plex" must not close upon the first tour but must advance before closing, from A to B at least. If, for instance, Fig. 15 had possessed 119 instead of 120 bars the required condition would have been fulfilled. The first tour would have ended not on bar 1 but on bar 2, the second on bar 3 and so on, the winding closing only when all the bars had been used. The last tour would have begun on bar 20—that is to say, the winding would have advanced from bar 1 (the beginning of the first tour) to bar 20 (the beginning of the last tour)—that is, through one double pole pitch exactly, before closing. A winding which closes after having advanced through one double-pole pitch only is the simplest wave-winding possible, and, providing it has made use of all the bars, is called a simplex singly re-entrant winding.

If, now, to such an armature another winding were added, precisely similar to the first, its bars lying alternately with those of the first, the armature would be said to have a duplex doubly re-entrant wave winding (usually called a duplex doubly re-entrant *series-parallel* winding).

The development of the wave-wound drum from the ring presents no difficulty. The idle bars of the ring winding are laid each between two active bars, and thus themselves become active. The idle bar b of Fig. 15 may, for instance, be laid between the active bars 10 and 11, or with about equal advantage between 9 and 10 or 11 and 12, since each of these positions is about the middle of a north polar region. To lay the bar b between 17 and 18 would result in a smaller E.M.F., since there would then be moments during which the bars b and 21 would lie both in the same polar region and would have opposing E.M.F.s. So long, however, as the distances 1 to b and b to 21 are each about one pole pitch the exact position of b may be chosen so as best to suit the mechanical conditions of winding, without appreciably affecting the E.M.F. generated.

The plexity of a wave winding is given by the number of double-pole pitches advanced through before joining up; the re-entrancy is, of course, the number of separate and distinct sections in the winding, and the multiplicity is the product of the plexity and the re-entrancy. A ring winding progresses, for each tour, by m spaces, and since each ring space makes 2 drum spaces we see that a drum wave winding progresses by $2m$ spaces per tour. One double pole pitch is $2y$ spaces, and so we have—the plexity x = (L.C.M. of $2y$ and $2m$) ÷ $2y$, and since r, the re-entrancy = m/x, we may write r = ($2ym$) ÷ (L.C.M. of $2y$ and $2m$) = ½($2y \cdot 2m$) ÷ (L.C.M. of $2y$ and $2m$) = ½(G.C.F. of $2y$ and $2m$), i.e.,

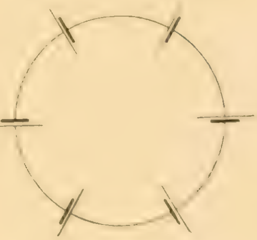


FIG. 16.

r = G.C.F. of y and m.

The rules therefore for a wave winding of any multiplicity and re-entrancy are:—

z must be even,
$z = py \pm 2m$,
r = G.C.F. of y and m,
y_f and y_b must both be odd and may, if desired, be equal.

Multiplex wave windings, more usually known as series-parallel windings, were patented in 1891 by E. Arnold, to whom their commercial development is due, and who first showed that with such windings the use of equalising connections is possible. Modern practice avoids the use of these as of all forms of multiplex windings, whether lap or wave, though a large number of successful commercial machines of considerable output are in use, especially those manufactured by the Lahmeyer Company of Frankfort.

(*To be continued.*)

E

The Control of Large Amounts of Power.

The following is an account of a discussion which took place before the Birmingham Local Section of the Institution of Electrical Engineers on Mr. E. B. Wedmore's Paper on the above subject. An abstract of the Paper appeared in The Electrician of March 8.

[illegible] said the Paper dealt mainly with protection by reactances. [illegible] devices were concerned this appeared [illegible] protection available. Reactance was necessary [illegible] of the consuming device on the customers' premises and for the circuit breaker which controlled this device. Such a liberal use of reactances would lower the power factor, which might at present be unavoidable. But was it also necessary to have reactances in the generating station, thus making the power factor still worse? It was true that synchronous generating machinery required [illegible] reactance, but need we employ such machinery exclusively? We must have some such machinery to fix voltage and frequency, [illegible] only supply a small part of the total power output. If the bulk of it were supplied by asynchronous generators the use of reactance coils cum extra heavy circuit breakers would be restricted to this small synchronous part of the generating plant.

The possibility of omitting all automatic protecting gear in the leads from the induction generator to the bus-bars would be obvious if one considered how such a generator was excited. If an asynchronous and a synchronous machine were coupled in parallel and the asynchronous machine rigidly connected to the bus-bars, and there was no means of switching it off, what would happen in the case of a partial or dead short? Obviously the first thing would be a lowering of the voltage. If the accident was a dead short on the bus-bars the circuit breaker would come out, and if the reactance of the synchronous machine was sufficiently large, the circuit breaker itself would not be damaged. If the fault had occurred somewhere outside the station, the reactance in the particular feeder would prevent the voltage at the 'bus bars from dropping to zero, but the reactance of the synchronous generator would come into action. The asynchronous machine derived its excitation from the 'bus bars and its terminal voltage could not exceed that of the 'bus bars; nor could it give an excessive current if the governor held the engine sufficiently near the normal speed to prevent the generator from breaking step. The current might be doubled and the E.M.F. halved so that the circuit breaker would have to deal with about normal kilovolt-ampere. If the governor failed also, then the engine raced, the full load was thrown on the synchronous machine and its circuit-breaker must come out. Thus the protection given to the synchronous [illegible] protection for the asynchronous machine coupled in parallel with it.

Asynchronous machines had been used in generating stations. There was, however, a difficulty in using such a machine without some device for improving its power factor. Even if it were possible to make the induction generator with so little leakage that its power factor were practically unity, we could not use such a machine without throwing an enormous wattless current on to the synchronous generator coupled [illegible] synchronous machines [illegible] were lighter and required no [illegible] in switchgear. But as long [illegible] their defects as regards [illegible]

[illegible] and a generator was designed to give a leading current of which the wattless component was not only [illegible]

[illegible]

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	600
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	10
[illegible]	[illegible]	[illegible]
[illegible]		[illegible]
[illegible]		[illegible]

[illegible]

able saving in cost. The open circuit slip-ring voltage was 16,000, which was really quite safe. In a motor one seldom liked to go higher than 600 to 800 volts. A motor must start itself. But a generator was started by its engine and only switched on when at speed; then there was very little slip and the slip-ring voltage was enormously reduced. The only point to be considered was how to close the circuit. The engine must govern so that the slip-ring voltage should not exceed the 600 or 800 volts considered safe for an induction machine. Roughly the slip volts were 0·01 times the percentage of error in the governing. Thus, if the speed at the moment of switching on were 4 per cent. too high the slip rings would get for a moment 700 volts; if 4 per cent. too low 550 volts. In the former case the engine would instantly slow down and in the latter be speeded up to the normal. There was no difficulty in obtaining a governor to regulate the speed closer than 4 per cent. If the machine was switched on when the speed was too low there were advantages in the vibratory over the rotary type of phase advancer.

According to this plan only one-third or one-fourth of the total plant at a generating station would be of the synchronous type, the rest would be asynchronous. Only the synchronous machines would be protected by reactance coils and extra heavy automatic circuit-breakers rated to stand about 7 times the normal current as the author suggests. Also only these machines need synchronising gear. The remaining two-thirds or three-quarters of the plant would be asynchronous and need neither reactance coils for their protection nor need they be provided with circuit-breakers of a higher than normal rating. Thus far the method of generating here suggested seemed feasible, but in translating it into a concrete form some care would be required to avoid the danger of instability, as there was no control over external power factor and external load. It might be necessary to make a compromise between stability and efficient protection on the one hand and cost of plant on the other. Stability might be obtained by making the kilovolt-ampere capacity of the synchronous plant large, but this increased the cost. But as some expenditure was saved in reactances and oil switches the advantage might still be with the combination of synchronous and and asynhronous equipment he had suggested.

Dr. C. C. Garrard remarked that the author's remarks on the construction of reactance coils were interesting. One type of apparatus shown was open to objection on the ground of the exposure of such a large amount of bare metal at high voltages. It would be better to enclose it in a steel tank filled up with oil. It was not necessarily an advantage for all parts to be fully open to inspection. This did not apply to an oil-filled transformer which was one of the safest pieces of electrical apparatus. If the reactance coil was in a steel tank, it was necessary to provide it with some kind of an iron cover—this rendered the arrangement difficult for feeder reactances. The short-circuit current might be, say, 30 times the normal full-load current through the coil, and there was danger of the iron circuit becoming magnetically saturated; as a result, although the current would be increased 30 times, yet the reactive effect would not have increased to the same extent. Thus the protective effect as regards short circuit compared badly with the unavoidable reactance drop at full load. For 'bus-bar and generator reactances the short-circuit current would not generally exceed 10 times the normal current, and this would allow iron-clad coils to be used. The author assumed that the limiting feature in regard to the extension of supply systems was in the distribution system rather than in the generating station. But the trouble could be overcome in the distribution system by an improvement of known apparatus, although it might be more economical to instal reactances in some cases. So far as the distribution was concerned it was *possible* to do without reactances. As regards the generating station, however, he thought it was not possible, and that reactances were absolutely necessary. Thus, the true limiting feature was within the generating station. Objection had been raised to types of switches in which the moving contacts moved upwards in the oil, so that the head of oil was continually diminishing during the operation of breaking circuit. In other types the moving parts of the switch moved downwards and thus the head of oil increased and the rush of current on short circuit tended to open the circuit quicker by increasing the repulsive force tending to press the moving contact downwards.

Mr. W. Wilson remarked that the greater portion of the Paper dealt with a simple piece of apparatus. This was certainly a welcome change after some other developments of power-house design. The presence of an iron circuit was a drawback to a current limiting reactance. The ideal state of things would be a device with no reactance at normal loads, but with a high one when overloads occurred, a combination that seemed difficult to attain. He would like to ask what was the extent to which the passage of this flux was felt in the vicinity, *e.g.*, if a portion of the iron framing of the building might come within the field, and if a mass of metal near by might offer itself as a short-circuited secondary. There was also the possible interference with meters, though modern instruments would be free from this risk. Probably the reactances being [illegible] in groups of three permitted the phases largely to neutralise [illegible] so far as stray flux was concerned. The iron tank proposed by Dr. Garrard would act as a screen for these stray lines. He did not understand the importance the author attached to the exposure of parts. It [illegible] him that the danger attending the exposure of these high-tension conductors was a definite weakness, and that some kind of cover was not only justified, but necessary

Mr. R. A. CHATTOCK agreed that the large supply systems now being built up made an effective control more difficult to obtain. The use of reactance was detrimental to the proper maintenance of the voltage throughout the system, and made regulation of the pressure more difficult. It, therefore, seemed desirable to consider if the current could be limited in some other way. The extension of the areas of supply would also require higher pressures to be used for distribution, *e.g.*, 20,000 to 30,000 volts. If the switching was done at these pressures, the amount of current to be controlled would be far less than at pressures of 6,000 volts, and this should render the use of reactances in and beyond the 'bus bars less necessary. It would probably be found that reactance could be confined to the alternators and to the transformers, which would be external to them but would constitute with them one generator unit. Reactance was necessary here, partly for the protection of the machines themselves and partly to prevent excessive rushes of current into faults on the system, but he deprecated the use of reactances in the 'bus bars if at all possible. The author stated that selective protective apparatus threw a severe duty upon the switchgear. This was not the case on an earthed system with a limiting resistance; nearly all faults were primarily earth faults which often developed into short circuits between phases, and if the selective apparatus could cut out the faulty section while its fault current was limited, the strain on the switchgear would be easily met. Again, the balancer current protection as applied to split conductor cables enabled faults to be eliminated before the current values had got out of hand. The development of these methods would seem desirable before adopting the use of reactances in the distributing system. As regards the desirability of two spare generator units of the largest size in a station, it was proposed to link up these large stations by substantial links, and in this way one spare should be sufficient in each station.

Radiation from Systems of Electrons.

In addition to his six Royal Institution lectures, which we have abstracted,* Sir J. J. Thomson delivered on Friday, March 22nd, a discourse on "Radiation from Systems of Electrons." In this he dealt particularly with the phenomena which are generally discussed under the heading "Röntgen Rays and Crystal Structure," though he did not use that expression. In his introductory remarks Sir Joseph referred to the scattering of the light falling upon two electrons, such as A and B at distance d in Fig. 1 given also in our issue of March 8th. A demonstration of the scattering was given with the aid of two knitting needles, which were fixed obliquely to a beam of light passing through a vertical slit. Each needle gave on the screen an arc of light. Whether or not the two radiations scattered along the paths OAP and OBP to any point, P, would support one another depended upon the relative lengths of the paths. The maximum scattering would result when the two paths were equal to one another, and therefore the angles of incidence and reflection also equal to one another. When the paths differed by whole wave-lengths (λ) there would also be reinforcement, and as points occupy

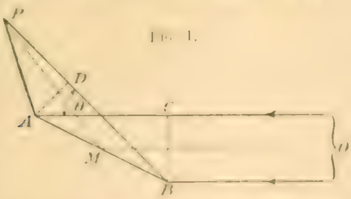


FIG. 1.

[illegible]

relative positions of the electrons. With many electrons it was not always possible to find a position of coincidence or reinforcement; but a series of rings or spots would result. When the electrons were arranged in an elementary cube the case would resemble that of a three dimensional grating; but the effect could not be demonstrated. But when two gratings were so superposed in a plane that the beam was normal to both the gratings and the two rulings crossed at right angles, eight bright spots were seen, four at the corners of a square and four half way between these; each spot was oval, blue near the centre, red outside.

The interpretation of the pattern of spots obtained by letting Röntgen rays fall on systems of atoms and electrons in crystals was not easy. The geometrical method generally applied was more complicated than a simple method which Sir Joseph indicated. This method resolved itself into the problem of finding three numbers, the squares of which summed up to the square of the given number. Let the ratio d/λ, where d was the side of the elementary cube of the space lattice, be $d/\lambda = 5$; then and [illegible] $= 25$. Two answers were possible: $5^2 + 0^2 + 0^2 = 5^2$ and $3^2 + 4^2 + 0^2 = 25$; the ratios $\frac{5}{5}, 0, 0$ or $\frac{3}{5}, \frac{4}{5}, \frac{0}{5}$ represented [illegible] of the spots on a system of orthogonal coordinates. Similarly, 9^2 could be resolved into $9^2 + 0^2 + 0^2$, $8^2 + 4^2 + 1^2$, $7^2 + 4^2 + 4^2$, $6^2 + 6^2 + 3^2$, and the cosine ratios would be $\frac{8}{9}, \frac{4}{9}, \frac{1}{9}$ [illegible] three right angles) were drawn, any point on that triangle would giv[illegible] Röntgen rays fall on a glass tube filled with the crystalline powder [illegible] hence doubtful.

[illegible]

* See THE ELECTRICIAN, March 8th, p. [illegible], and March 29th, p. [illegible].

Books Received.

[illegible]

The Electrician.

FRIDAY, APRIL 5th, 1918.

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The Improvement of the Turbo-Alternator.

The Institution of Electrical Engineers was fortunate in being able to secure at this time such an important Paper as that contributed by Dr. S. F. Barclay at the last meeting. Those interested in this branch of heavy electrical engineering will welcome the informative discussion, as well as the correspondence in these columns upon certain of the matters which were not cleared up by the discussion.

One of the principal questions under discussion is that of the solid rotor *versus* the built-up rotor for machines of large output. At first sight the former appears to possess many advantages over the latter; but, on closer examination, it will be found that, except for small machines, the solid rotor construction has inherent defects, the elimination of which has not yet been accomplished. The larger the diameter, or the greater the volume, of the rotor the more likely are the defects to become pronounced.

In addition to the possibility that the forging may be unsound, there appear to be four drawbacks to the solid rotor.

Records show that the ductility varies considerably throughout the mass.

Evidence is not wanting to prove that the hest treatment—which gives the desired characteristics to the material—does not penetrate to the centre of a large forging, nor is it uniform in the case of a hollow forging having walls of considerable thickness. In this connection it may be noted that, although research on the subject is lacking, a large mass of steel, after heat treatment, in some cases seems to be liable to slow molecular change.

A large forging can neither be tested nor inspected with the same degree of thoroughness as the test and inspection methods in everyday use in the machine shop.

Finally the user is faced with the difficulty of obtaining forgings. It is probable that, at the most, not more than half-a-dozen firms in the country are in a position to undertake such work. Forgings of the requisite quality cannot be obtained from abroad, and the user is thus restricted to a few firms which may be working under an agreement as regards price and delivery.

In the built-up rotor, none of the objections set out above are present to any extent. With the plates being thin no part is more than, say, an inch from the surface, and, beyond question, the heat treatment of such a plate is likely to be more dependable than that which can be given to the solid forging.

As regards construction, however, the difficulties are very much greater in the case of the built-up rotor. An approved method of constructing such a rotor is to use a number of thick plates [illegible] one another, the plates which are solid in the centre being held together by four large bolts near the periphery. Although the manufacture of such plates calls for workmanship of the highest quality and accuracy, it is well to remember that rigorous tests can be applied at every stage. Furthermore, these tests are of a kind in common use in engineering shops and are therefore generally understood by engineers.

We have mentioned the difficulty of obtaining satisfactory forgings. In the case of plate-type rotors, not only can the plates be readily obtained in what is, virtually, an open market, but the machining can be done outside by one of the many firms having suitable equipment for, and competent to undertake, the work. We believe that this plan has been adopted in the past by one of the large American firms in order to secure prompt deliveries. Judging by the high standard of excellence that has been reached in recent years it is not unreasonable to suppose that there are firms at home able to undertake the mass production of such plates if called upon to do so.

In both types, the problems to be solved in turning out a satisfactory job are as numerous as they are difficult, and we share Dr. Barclay's view that the turbo-alternator in its present form is creditable to the engineers who have taken part in its development. At the same time we are of opinion that many of the problems connected with the design, both of stator and rotor, need further investigation. Thus, if outputs become restricted owing to insufficient cooling surface, or inefficient cooling surface, it is evident that, since the area of the cooling surface cannot be greatly increased, means of improving its efficiency will have to be found before there can be any radical increase in the specific output.

Improvements in the design and construction of the end-bells or, preferably, improved design and arrangement of the rotor winding of such a kind as to eliminate the end-bells, would simplify the design. As far as we are aware the problem of the end-bell has not yet been made the subject of extended mathematical investigation by the elasticians, and, to a very large extent, the safety of such bells is due more to the factor-of-safety than to scientific design. We believe that investigation would show a relatively light wire-wound drum to be superior to the composite structure at present in use. Problems of greater difficulty have already been solved by the designer.

The question of noise, also, is one which could, with advantage, be further investigated; and it is likely that a systematic research would lead to good results. Both the improvement of the cooling surface and the "silencing" of the machine are problems which the physicist is better qualified to solve than is the engineer; but it is likely that the best results would be obtained by the two working in concert. By systematic research we mean the methods of a National Physical Laboratory coupled with the unrestricted facilities and finance of a large engineering works. It is to be regretted that by many research is still regarded as the sort of work which can safely be given to rather tame individuals having a slight knowledge of physics and none of engineering.

In passing, it may be noted that the truly awful noise emitted by many turbo-alternators is due to unscientific design of the fans. Many of the latter appear to violate every rule of fan design, and improvements in such cases could be effected, without research, by one conversant with the elementary principles of design of ventilating fans.

As regards the electrical side of the problem it is a little difficult to forecast developments. Without epoch making discoveries the designer will have to be content with copper and its troublesome losses and defective mechanical properties. The improvement of insulating materials is work for the skilled chemist with the unrestricted facilities and finance mentioned above. From the magnetic point of view the outlook is a little more promising, and it is not unlikely that further work on the iron alloys will result in an improvement in the magnetic properties as well as in a reduction of the specific loss in commercial iron.

On many occasions attention has been directed to faulty end connections. The fault is entirely mechanical. It was not till a number of machines had been wrecked that the necessity for adequate bracing was recognised. Nowadays such bracing is provided; but many a good job is spoiled by improper fixing of the end connections to the inductors. Some designers still rely in whole, or in part, on solder for the making of the joints. This is the easy way, but we hold very strongly that it is bad engineering. The proper method is to minimise the number of joints, and to have tinned contact surfaces, the larger the better, and to rely on rivets or large bolts, for maintaining good contact.

Many engineers and users seem to specify an overspeed test in much the same way as they call for an overload test. In our opinion the idea of the overspeed test is fundamentally wrong, and from every point of view it is preferable to call for an emergency overspeed governor of good design and of robust and powerful construction. Were we in charge of such machinery we should make a practice of testing the overspeed governor each week. To us this appears to be preferable to a method of testing which may damage the machine and which will certainly not save the machine in case the overspeed governor fails to act in an emergency.

In concluding our brief survey, we regret that engineers are averse to bringing forward examples of faulty design and construction with which they are familiar. Such examples in themselves form a liberal education, and as such go a long way towards promoting the objects for the achievement of which engineering institutions are founded. We imagine that most of those who took part in the recent discussion at the Institution of Electrical Engineers could have furnished several such examples. In our opinion he is a poor sort of engineer who endeavours to make capital at the expense of a fellow engineer. And of this he may be certain that the more *original* the work of the designer the more mistakes will he make.

Reviews.

Handbook of Machine Shop Electricity. By C. E. CLEWELL. (London: Hill Publishing Co., Ltd.) Pp. xi + 461. 12s. 6d. net.

This handy volume, which was compiled at the suggestion of the editors of the "American Machinist," is intended to fill a need for an electrical reference book adapted to the machine shop. In our opinion the book will be found useful in a much wider field. For instance, the section devoted to commutation and distant control will appeal to many engaged in electric installation work. Section V, on D.C. and A.C. supply, sets out in small compass the essentials of the subject, [illegible] responsible for the maintenance of the supply will find anything new in this section.

It should be mentioned that the book opens with a useful list of abbreviations, and this list is followed by a classification of machinery and equipments. The discussion of electrical machinery [illegible] in this section is fairly illustrated, as indeed is the entire book, and the dictionary could, with advantage, be amplified in subsequent editions.

The second and third sections, which deal respectively with circuits and costs, contain a good deal of useful information, but it should be noted that the author is describing American machinery and practice. It occurs to us that it would be a good plan to include certain parts of the National Electric Code for the use of American readers as well as the parallel rules, if they are followed by the wiring fraternity, in this country. In America the Code is a factor to be reckoned with in all installation work, but at home probably not one wireman in ten has yet heard of the existence of the I.E.E. Rules. In Sections VI and VII will be found much reliable and useful information on welding, electrochemical principles, and heating and magnetic apparatus.

Lamps and shop lighting is too wide a subject to be covered by 20 pages, many of which are taken up by diagrams of doubtful utility when viewed from the point of view of the man in the machine shop. The same remark applies to Section IX, on Instruments and Measurements. Not one man in a thousand is interested in automatic voltage regulators, frequency and synchronism indicators and the like. Nevertheless, praise is due to the author for including notes on the analysis of shop operations by graphic meters. Amplification of these would be welcome.

The remainder of the book deals with Motors and Applications. The man in the shop will find plenty in these [illegible] pages to interest him. As motor ailments and running repairs are nightmares to most non-electrical users of the electric motor it is thought that strong and carefully written sections on these subjects would be helpful to many readers. As it stands, however, the book is as good as any we have seen on the subject with which it deals. H. H. B.

The Driving of Machine Tools. By THOS. R. SHAW. (London: Scott, Greenwood & Son.) Pp. viii + 221. [illegible] net.

This book, which is one of the "Broadway" series of engineering books, is the outcome of a series of lectures at the Royal Technical Institute, Salford. Had the author confined his attention to the mechanical side of the subject, and dealt more fully with the subject-matter of six of the chapters, his book would have been useful to designers and users of machine tools. Had numerical examples been given, the book would have been used by a very large number of machine-tool draughtsmen.

As it stands, we believe that the book will be a disappointment to many. The matter in the sections dealing with the mechanical side is good as far as it goes; but, in our opinion, it does not go far enough. The matter on the electrical side is unconvincing, dismal stuff, innocent of body.

The reviewer makes bold to say that the electric driving of machine tools is too wide and serious a subject to be treated in a superficial manner. Furthermore, he would observe that the electric motor and its control cannot be dealt with usefully in a dozen or so pages with large half-tone illustrations thrown in to fill up obvious gaps.

Judging by the truly awful examples of electric drive which abound, even in the workshops of the electrical manufacturers, it is evident that users stand in need of education. The book for such people has yet to be written.

Annuaire pour l'an 1918. (Paris: Gauthier-Villars et Cie.) Pp. [illegible] + 870. 2 fr.

This annual for 1918, issued by the Bureau des Longitudes, is considerably larger than the edition for the previous year. The main portion of the volume, occupying 676 pages, contains a very complete series of tables relating to astronomical and meteorological data, computation of time, terrestrial magnetism, [illegible]

The [illegible] part of the work contains a number of contributions on special subjects, separately paged. M. G. Bigourdan deals with the [illegible] Calendar, M. [illegible] with [illegible], M. Maurice Hamy with [illegible] Terrestrial Magnetism. [illegible]

[illegible] interest, apart from its special technical application.

Glover's Vade Mecum. (Manchester: W. T. Glover & Co., Ltd.) Pp. [illegible]

As the name suggests, this work is a compact handbook on cables. It is divided into eight sections, dealing respectively with construction of cables, cable laying, [illegible] overhead lines, maintenance and testing of cable systems, useful data and formulæ, regulations governing installation and supply of electricity. Full particulars are given in the tables of standard gauges, dimensions, weight, conduc-

tivity, &c., both for single and stranded conductors, and some data are also given for aluminium. The description of various types of insulated cables, telegraph and telephone work, sheathing, &c., is practical, and the data on working pressures are useful. The sections on installation and maintenance are well illustrated, and the summary of methods of testing adequate. We commend the book to all concerned with cable work.

Correspondence.

RATIONING GAS AND ELECTRICITY.

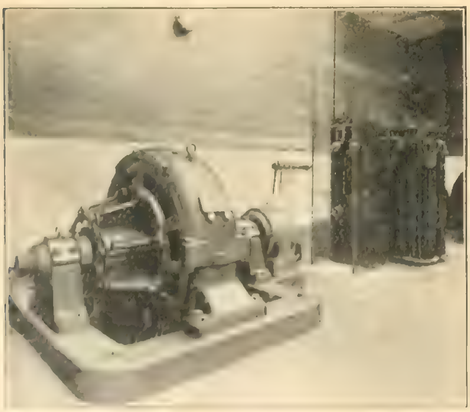
TO THE EDITOR OF THE ELECTRICIAN.

Sir: This is doubtless a wise precaution, but the necessity for limitation of supply, for real wants, accentuates the need for reduction of waste, as evidenced in our streets. In Piccadilly we have gas lamps still producing their thousands of candle-power inside a metal cylinder which allows 20 c.p. or 30 c.p. to issue in a downward direction. The same remark applies to the electricity waste in other parts, such as St. Pancras, where active men are seen climbing to trim 2,000 c.p. arcs, which are allowed to throw a glimmer on the pavement at night.—I am, &c.,

London, March 29. Edward C. Barton.

The Blackfriars Sub-Station of the Salford Corporation.

The Salford Corporation have recently erected a new sub-station at Blackfriars, Salford, the equipment including a 500 k.w. "Witton" shunt-wound rotary converter, which is shown in the illustration. The set runs at a speed of 750 revs. per min. and generates continuous current at 430-470 volts. Three-phase power is taken from the Corporation mains at 6,600 volts, being transformed down by means of an air-cooled oil insulated transformer, seen in the background of the illustration. A switch panel accommodating the low-tension controlling gear for the converter is fixed adjacent to the



[illegible]

[illegible]

Vickers Rotary Converters and Electrical Crane Equipments.

Two recent publication by Messrs. Vickers (Ltd.) deal with rotary converters and electrical crane equipment. Rotary converters are now in considerable demand, and supply companies, factories and railways are in many cases making a practice of putting down plant to convert power received from large outside alternating supply companies to direct current. A discussion of the two chief methods of converting a three phase bulk supply to direct current is presented in the first of these pamphlets, and a comparison is made of the advantages of motor generators and rotary converters. Next, there are notes on compound wound rotary converters, the regulation of direct current voltage, and various subsidiary points, such as the use of commutating poles, hunting, excitation and the effect of power factor and choice of frequency. The usual methods of starting up rotary converters and the functions of the inverted rotary are described. Finally, a complete model specification on rotary converters is presented.

The other leaflet (No. 201), dealing with electrical crane equipments, contains a neatly executed sheet of coloured illustrations of controller, crane panel, automatic contactor panel, grid resistance and crane motor, and a model "questionnaire," showing the chief items of information to be stated when ordering crane equipnemts, is supplied.

Legal Intelligence.

Great Eastern Railway Co. v. Postmaster-General.

As briefly stated in our last issue, Mr. J. H. Oakley, as arbitrator, commenced the hearing of the claim by the Great Eastern Railway Co. of £33,393 as compensation for taking the subsoil for the Post Office Tube Railway under Liverpool-street (London) Station.

Mr. G. M. Freeman, K.C. (for claimants), said the construction of the line under Liverpool-street would considerably interfere with the user of the sub-soil. The Great Eastern had traffic of startling magnitude, and it was impossible to further enlarge Liverpool-street Station on the surface. All they asked Parliament to do was to safeguard such a stratum of the subsoil above the Post office tube as would enable the company to use it for an underground station. The top stratum was preserved by a clause of the Act, the remainder was left to compensation.

Col. H. W. Thornton (general manager and engineer-in-chief of the Great Eastern Railway Co.) said there was no way of extending Liverpool-street Station except by going underground. In order to relieve the traffic congestion the railway must be electrified, and it would be necessary to construct an underground station beneath the present station. There had been a very great development in the traffic, notwithstanding the great development in tramcar and motorbus services. If a considerable sum of money was spent it must be spent to electrify the Great Eastern for the suburban zones, and through connection with existing tube lines or through the construction of an independent tube line they must place their passengers in the heart of the financial district and in the shopping districts.

Sir Alex. Stenning (surveyor) said in making his valuation he took a surface area of 21,791 ft., and valued it at £3 per foot £65,373. He took 10 per cent. of that as the value of the subsoil -£6,537. Three vaults valued as in occupation at £25 each per annum at 20 years' purchase £1,500. Adding 10 per cent. for compulsory acquisition made the total £8,840 in regard to the land occupied. In regard to severance, he estimated depreciation of £6,744 (at 7½ per cent.) on land valued at £89,922, and of £17,809 (at 5 per cent.) on land valued at £356,181, making the grand total of £33,393.

Mr. C. A. Lang (surveyor) said he had made a valuation amounting to £33,111, and Mr. Denny's estimate was £32,470.

Mr. H. H. Dalrymple Hay (engineer of the Post Office Tube Railway) gave evidence for the respondents, and Mr. L. R. Vigers (surveyor) assessed the compensation at £4,269, while Mr. H. Martin (surveyor) calculated it at £4,100, and Mr. Douglas Young (surveyor) at £4,270.

Mr. E. A. [illegible] (Inland Revenue valuer) said he had negotiated in over a hundred cases for the easements of the Post Office Tube Railway, and all these cases had been settled on the conventional rate.

The Solicitor-General (Sir Gordon Hewart, K.C.), for the Postmaster-General, said the schemes of which they had heard came into existence after it was decided to make this claim, and they could be carried out without being hampered by what was being done by the Post Office. The subsoil 55 ft. below the surface could only have a most fanciful and speculative value. Just compensation could be obtained under the provisions of the Act without asking an arbitrator to exercise his imagination as to something on which no information could be offered.

The Arbitrator reserved his award.

Agreements with Firms in Enemy Countries.

In the High Court last week Mr. Justice Bray dealt with three applications for declaration that the plaintiffs' agreements with firms trading in enemy countries had ceased to be valid.

His Lordship was asked to make a declaration that two contracts entered into by the Gröndal-Kjellin Co. (Ltd.) with the Siemens and Halske A.G. of Berlin, became dissolved on the outbreak of the war. The matter came before the Court in December and was adjourned.

Mr. STUART BEAVAN, for the applicants (the Gröndal-Kjellin Co.), said the agreements related to patents for processes in the manufacture of electric furnaces used for making high grade steel. The first agreement gave rights to the defendants for the United States and Canada with the right to grant licences. Counsel understood an American company referred to in correspondence which he read, were licensees under defendants of some of the patents, but the order asked for would not affect their rights. The second agreement, in the same terms, covered the British Colonies.

His LORDSHIP made the declaration asked for.

An application was made under the Legal Proceedings against Enemies Act, 1915, by Pintsch's Electric Mfg. Co., of Croydon, for a declaration whether royalties were payable to Mr. Hugo Grob, patentee of apparatus for use in electric lighting on trains. The respondents were Messrs. Hugo Grob and Julius Pintsch A.G., Berlin.

Mr. J. H. STAMP, for plaintiffs, said the Julius Pintoch A.G manufactured the apparatus in Berlin, and it was agreed that plaintiffs were to get the supplies from them and pay royalties to them and to Mr. Grob. The respondents took £5,000 worth of shares in the plaintiff company.

Mr. C. P. WHITCOMBE (managing director of the plaintiff company) said owing to the war the plaintiffs were held up as to the supply of the apparatus. They had not the facilities for its manufacture, but arranged to keep in order apparatus already supplied. The royalties were to be 5 per cent. on sale price, subject to certain minima, and went on accruing under that minimum clause. They wished to get rid of that liability.

Mr. STAMP said Mr. Grob was mistaken in stating that he was not liable to proceedings on the ground that he was a neutral, as the Act stated that neutrals trading in an enemy country were to be treated as enemies. Mr. Grob's writing from Zurich was merely "camouflage."

His Lordship made a declaration that the agreement was dissolved on the outbreak of war, but without prejudice to all other questions that might arise between the parties concerned.

The Thermo-Electric Ore Reduction Co., of London, asked for a declaration that an agreement between themselves and the respondents, Gebrüder Roebling, of Saarbruck and other places in Germany, was dissolved as a result of the outbreak of war.

Mr. THEOBALD MATHEW, for plaintiffs, stated that they were smelters of wolfram concentrates, and produced ferro-tungsten used in steel manufacture. In 1913 respondents were appointed their agents, and plaintiffs agreed to supply a minimum of 700 tons of ferro-tungsten per annum. Respondents took 1,000 shares in the plaintiff company.

His LORDSHIP made the declaration that the agreement was dissolved, without prejudice to liabilities already incurred.

Patent Record.

SPECIFICATIONS PUBLISHED

[illegible]

1917 [illegible]

[illegible] magnet coils. (24 5.16.) (Addition to 3,919 12 [illegible]

[illegible] (10 4 17.) 113,164 [illegible]

6,298 [illegible] 113,4[illegible]

6,699 BRITISH INSULATED & HELSBY CABLES LTD. & BLADES, R. W. [illegible] cables. (11/5/17.) 113,378.

6,700 BRITISH INSULATED & HELSBY CABLES LTD. & BLADES, R. W. [illegible] cables. (11/5/17.) 113,379.

6,725 HUNTER, P. V., BEARD, J. R., & ELECTRICAL IMPROVEMENTS, LTD. Protection of electric distribution systems. (11/5/17.) 113,380.

8,814 [illegible] 113,391.

9,404 [illegible] combustion engines. (29/6/17.) 113,220.

10,242 [illegible]

12,724 [illegible]

13,713 [illegible] dynamo and electric motors. (11/10/16.) 110,353.

13,951 [illegible] (27/9/17.) 113,411.

14,455 SMITH, H. B., & ELECTRIC PULLEY BLOCK CO. Electric pulley blocks. (6/10/17.) 113,415.

15,844 [illegible] (Addition to 100,281.) 111,475.

1918 SPECIFICATION.

[illegible] GILL, H. A. (U.S. Light & Heat Corpn.) Variable-speed generators and storage [illegible]

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications [illegible]*

February 14, 1918.

2,648 WRAY. Gas fires electric radiators, &c.
2,663 B.T.-H. Co. (G.E. Co.) Electric fluid turbines.
2,664 ASH. Electric motor control systems.
2,676 FULLER WIRE & CABLE CO. Electric conductors.
[illegible]

February 15, 1918.

2,745 WHITACHER. Electric distribution systems.
2,746 B.T.-H. Co. (G.E. Co.) Electron discharge devices.
[illegible]

2,768 ROWAN. Apparatus for den[illegible]
[illegible]

February 18, 1918.

[illegible]

February 19, 1918.

2,877 MACDONALD. Electrolytic gas process.
[illegible] tricity
[illegible] magnets.
[illegible]
2,913 B.T.-H. Co. (G.E. Co.) M[illegible]
[illegible] Electric gas lighters.

[illegible] lectric traction.
3,013 BRITISH A[illegible]
[illegible]
3,022 B.T.-H. Co. (G.E. Co.) Electric [illegible]
[illegible]

Volunteer Notices.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

[illegible]

Commercial Topics.

Reconstruction Committees.

[illegible] of Commerce have recently passed resolutions criticising the constitution of certain committees appointed by the Minister of Reconstruction.

In a letter to Sir Algernon Firth, president of the Association of [illegible], Dr. Addison now replies to the criticism and points [illegible] against the personnel of the Committees [illegible] that he is left in the dark as to [illegible] are regarded as unacceptable.

[illegible] the members [illegible] and the terms of [illegible] Trusts and on Financial Risks attached [illegible] Trade Organisation Committee. Dr. Addison forwards the terms of reference to this Com[illegible] Chambers of Commerce could not have had them before them when their resolution was passed.

Dr. Addison also reminds Sir Algernon Firth that he (Sir Algernon) was present at the preliminary conference when it was decided to ask the Association of Chambers of Commerce, the Association of Controlled Firms and the Federation of British Industries, to suggest the names of [illegible] was also agreed [illegible] should be invited and that the three Departments concerned (Reconstruction, Board of T[illegible] represented. [illegible] I [illegible] from these proposals either during or after the meeting, and I am naturally somewhat surprised [illegible] with your approval."

In reference to Sir Algernon Firth's statement that he (Dr. Addison) [illegible] of departmental officials with a small representation of business men," the Minister of Reconstruction states that Committees for which he was responsible up to that time were 19. Since that date he (Dr. Addison) had appointed [illegible] and Foreign Exchanges jointly with the Chancellor of the Exchequer), and the Committee on Trusts, and the Financial Risks Committee. He did not think that careful study of the constitution of those Committees could lend support to the view that they consisted mainly of departmental officials, or that he could be accused of having neglected the claims of business men to representation. In all those cases the only officials appointed were the chief officers of the different departments who dealt with the matters concerned.

* * * *

Trade Organisation Development.

A [illegible] which is to take place between trade representatives and Government representatives in the Saddlers' Hall, London, on April 12, will mark a new point in the process of trade organisation, [illegible] is now being given.

On behalf of the Government, three Ministries will be represented by [illegible] Dr. Addison, Minister of Reconstruction; Mr. G. H. [illegible], Minister of Labour; and Mr. Hayes Fisher, President of the Board of Trade. The trade immediately concerned on this occasion is the made-up leather goods and belting industry, and representatives both of employers and of employed will be present. The [illegible] to promote the formation, for this particular industry, of an "Interim Industrial Reconstruction Committee," and [illegible]

[illegible]

* * * *

Miners' Safety Lamps.

[illegible] Coal Mines Act 1911, [illegible]

The Order also amends and consolidates the specification of the "Ceag" Miners' Electric Safety Lamp approved by the Order of Aug. 26, 1913, and amended by later Orders, and also makes amendments in the specifications of certain other safety lamps approved by previous Orders.

* * *

National Metal and Chemical Bank.

The National Metal and Chemical Bank was registered on Saturday last, with capital £1,000,000, divided into 100,000 shares of £10 each, all subscribed privately.

None but British subjects may become directors, and provision is made to prevent control from passing into the hands of foreign interests. The bank is empowered to undertake all forms of banking, but will devote its activities primarily to developing the smelting and chemical industries of the Empire. It will be in a position to offer wider financial facilities to those engaged in the metal business than any ordinary bank. Considerable progress has already been made in erecting the smelters and refineries in this country to treat the raw materials produced in the Empire, which before the war were sent to Germany.

Electricity Supply.

Extensions.

London County Council.—At the meeting of the London County Council last week permission was given to the Hammersmith Council to borrow £5,879 in connection with their electricity undertaking. £3,400 of the loan is for plant.

Luton.—The Electrical Engineer has obtained priority certificates from the Director of Power Supply for the additional plant required.

General.

Barnsley.—The chairman of the Electricity and Lighting Committee (Ald. Rose) has resigned, and Councillor Cretney succeeds him.

Bexley.—The salary of Mr. H. P. Stokes, electrical engineer and tramways manager to the Urban Council, has been increased by £200 per annum as from Jan. 1, 1918.

Greater London.—The conference of local authorities owning electricity undertakings in Greater London has adopted constitution and rules in order that the conference may be placed on a permanent basis.

A subscription of £3 3s. per annum is required for cost of minutes of proceedings, from each Authority represented and four representatives (including the engineer and Town Clerk) are to be appointed from each authority annually in March.

Haslingden.—The Electricity and Tramways Committee has decided to increase the salary of Mr. Kay, tramways manager, to £225 per annum.

Mevagissey.—At the recent annual parish meeting the Lighting Committee reported that the local electric supply company could not light the 26 street lamps under £120 per annum. Consideration of the offer is to be deferred until the end of the summer.

Municipal Trading Departments and Relief of Rates.—Manchester and Salford Trades and Labour Council last week decided to protest, through their representatives in the Manchester and Salford Councils, against the increase of tramway fares and of the price of gas and electricity for the purpose of relieving the rates.

Manchester City Council last week adopted the report of the Trading Profits Special Committee as to the allocation of the profits of the gas, electricity and tramways departments to relief of rates, after rejecting a proposal to refer the report back, and an amendment to make the minimum contribution by the tramways department 1 per cent., as in the case of the other departments, instead of 5 per cent.

Portpatrick.—The Portpatrick Electric Supply Co. (Ltd.) has applied to the Board of Trade for the revocation of its electric [illegible] order on the grounds that it has not received the support [illegible] expected, and that there is no prospect of continuing the supply of current except at a loss. At a meeting last week, con[illegible] their willingness to agree to an increase of charges [illegible] to a cessation of supply.

Workhouse Lighting.—The Chorley Guardians have adopted plans for a new heating system, electric lighting installation and [illegible] to laundry and cooking apparatus at the workhouse, [illegible] cost of £6,750, subject to the L.G. Board's approval.

Electric Traction.

Birmingham.—The Tramways Committee is applying to the Board of Trade for permission to vary its present statutory obligation by reducing the penny stage below its present length of 2 miles.

Darwen.—The Tramways Committee has accepted the resignation of the tramways manager, Mr. F. J. S. Hoskens, and applications for the position at a salary of £250 are to be invited.

London County Council.—Under the scheme for the reorganisation of the electrical branch of the L.C.C. tramways department, it has been decided to increase the fixed staff by the appointment of two main inspectors at a commencing salary of £200, rising by £12. 10s. a year to £300 per annum.

At the meeting of the Council last week the Highways Committee reported having received a letter from the Tramways (Board of Trade) Committee, pointing out that great difficulty is being experienced by tramway undertakings in obtaining delivery of materials from contractors, and that it is necessary during present conditions that inviting tenders should be temporarily discontinued to enable orders for materials to be placed where delivery could best be made. The Highways Committee propose that until Oct. 31, 1918, the practice of inviting tenders for six or twelve months' supply of tramway stores and equipment be discontinued, and that offers be obtained from time to time for the supply of goods, &c., required for the tramways department, subject to a limit of £250 in any one case. The Council agreed to the proposal.

Newcastle-on-Tyne.—[illegible] Ald. Sir W. H. [illegible] at £14,000 [illegible].

Considering the times in which we lived, he did not think that should be d[illegible].

Mr. [illegible] this year they were £410,000, and the net surplus after making provision for [illegible] of [illegible].

Nottingham.—[illegible] the Corporation [illegible] increased to the [illegible].

Western Valleys (Mon.) Railless Traction Scheme.—The Board of Trade has extended [illegible] the Western Valelys (Mon.) Railless Electric Traction Act, 1913, and by the Western Valleys (Railless) Electric Traction (Extension) Order, 1914, for the completion of [illegible].

Imperial Notes.

Australasia.—The following particulars relative to proposed hydro-electric power development in the province of Southland (New Zealand) have recently been received at the Department of Overseas Trade: The Government are having a report prepared upon the question of the development of hydro-electric power in the province of Southland. That province has the largest amount of undeveloped water power in New Zealand, and it is proposed to develop a scheme that will yield a sufficient power to serve the whole of the province. The Southland League (Incorporated) has asked the Government to authorise districts such as Southland to carry out their own scheme.

Brown Coal.—The Expert Committee (Messrs. H. Herman, W. Stone, H. R. Harper and F. W. Clements) appointed by the Victorian Government to inquire into the prospects of [illegible] the Morwell brown coal deposits in the generation of electrical energy has submitted to the Minister of Mines a report [illegible] the immediate adoption of a scheme to establish a power house at Morwell, and to transmit electrical energy to Melbourne [illegible] and that the State should control all State and statutory electric supply [illegible].

[illegible]

Canada.—[illegible]

[illegible]

India.—[illegible]

[illegible]

Miscellaneous.

Trading with the Enemy.—The "London Gazette" of March 15 contains further additions to the list of firms or persons with whom trading by persons in the United Kingdom is prohibited. These include: [illegible], Siemens-Schuckert Elektriska [illegible], Stockholm.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during February, 1918, and (*b*) [illegible] from Jan. 1 to Feb. 28, with increase or decrease compared with corresponding periods of 1917:—

Electrical machinery, (*a*) £107,912 (increase £32,060), (*b*) £189,399 (decrease £19,782); including generators and motors other than for [illegible] £1,216); electrical wires and cables, rubber insulated, (*a*) £287 (decrease [illegible] £582), (*b*) £44,079 (increase £13,519); parts of arc lamps and searchlights [illegible] £5,092); primary and secondary batteries, (*a*) £14,907 (decrease £18,000), (*b*) £61,346 (decrease £16,038); meters and measuring instruments, (*a*) [illegible] apparatus unenumerated, (*a*) £24,640 (decrease £4,759), (*b*) £52,131 [illegible] machinery and uninsulated wire, (*a*) £55,876 (decrease £51,464), (*b*) [illegible].

Exports.—The exports of electrical machinery, material, &c., (*a*) during February, 1918, and (*b*) from Jan. 1 to Feb. 28, with increase or decrease compared with corresponding periods of 1917, were as follows:—

[illegible] (decrease £3,725), (*b*) £4,933 (decrease £3,820); other generators and motors except for aeroplanes, motor cars and cycles, (*a*) £40,303 (decrease £25,440), (*b*) £85,637 (decrease £84,241); and electrical machinery unenumerated, [illegible]; telegraph and telephone cables, submarine, (*a*) £33,287 (increase £4,215), (*b*) £50,356 (decrease £7,541); other than submarine, (*a*) £18,755 (decrease £10,546), (*b*) £37,347 (decrease £116,050); telegraph and telephone apparatus, (*a*) £16,724 (decrease £7,513), (*b*) £37,453 (decrease £4,141); other electrical wires and cables, rubber insulated, (*a*) £5,773 (decrease £9,633), (*b*) £12,383 (decrease £63,089); with other insulation (*a*) £7,714 [illegible] (decrease £6,415), (*b*) £15,454 (decrease £9,094); arc lamps and searchlights, [illegible] (*a*) £9,274 (decrease £7,455), (*b*) £15,663 (decrease £20,995); meters and measuring instruments, [illegible] £10,960); transformers, (*a*) £409 (decrease £4,452), (*b*) £5,137 (decrease [illegible] crease £8,523), (*b*) £71,745 (decrease £40,898). Total of electrical goods [illegible].

Tenders Invited and Accepted.

Turbo-Alternator, Surface Condenser, &c.

[illegible]

Government Contracts.—[illegible]

[illegible] W. [illegible] & Co., wire repairing apparatus; Automatic Telephone Mfg. Co., British L. M. Ericsson Mfg. Co., and Western Electric Co., telephone apparatus; W. D. Tucker & Sons, battery boxes; Siemens Bros. & Co. and Telegraph Construction and Maintenance Co., submarine cable; British Insulated & Helsby Cables, General Electric Co., W. T. Glover & Co., W. T. Henley's Telegraph Works Co., India Rubber, Gutta Percha & Telegraph Works Co., Johnson & Phillips, Union Cable Co. and Western Electric Co., telegraph cable; Peel-Conner Telephone Works, telephonic cable; Siemens Bros. & Co., Leclanché cells; British Insulated & Helsby Cables, London Electric Wire Co. & Smiths and Western Electric Co., telephone cords; General Electric Co., telephone cords; British Insulated & Helsby Cables and W. T. Henley's Telegraph Works Co., cable distribution plugs; Gent & Co. and Peel-Conner Telephone Works, telephones T. Bolton & Cons. British Insulated & Helsby Cables, Shropshire Iron Co. and F. Smith & Co. (inc. in London Electric Wire & Smith's, Ltd.), bronze wire.

Appointments Vacant and Filled.

An assistant lecturer attached to the engineering department is required by the City of Hull Education Committee for the day and evening departments of the Municipal Technical College. Salary £175, rising to £250, plus 5s. per hour for evening classes. Forms of application, &c., from Dr. J. T. Riley, Director of Education, Albion-street, Hull. *See advertisement.*

Applications are invited for the position of operation superintendent in the traffic branch of the London County Council Tramways Department. Salary from £600 to £800. Forms of application from the Clerk of the Council, Spring Gardens, S.W. 1. Applications by 1 p.m. April 15.

A mechanician with experience in construction of scientific instruments is required in Ayrshire. *See advertisement.*

Mr. Jas. Makin, of Stoke-on-Trent, has been appointed chief assistant of the Bexley electricity and tramways undertaking at £[illegible] per annum.

Mr. A. E. Val Davies, A.M.I.E.E. (of the Victoria Falls & Transvaal Power Co.) has been appointed assistant city electrical engineer at Capetown at a salary of £700 rising to £800 per annum.

Business Items.

Belling Baking Ovens.—We have received from Messrs. Belling & Co. a copy of their latest leaflet on standardised baking ovens.

The leaflet states the reasons why electric ovens should be adopted for the thousands of national kitchens which are being established. It is calculated that 1,000 electric ovens of about 100 lb. meat capacity would save at least 10,000 lb. of cooked meat a day, compared with other ovens, or rations for 50,000 people.

Formite Moulding Mixtures.—A new circular describing the Damard Lacquer Co.'s formite moulding powders, for which Messrs. Pirelli, Johnson & Co. (Ltd.), Minerva House, Bevis Marks, London, are sole selling agents, has been issued.

It is stated that amongst the properties of formite insulation are high dielectric strength, high electric resistance, and low absorption of moisture. The various classes of formite mixtures are made up with (1) fibre, (2) asbestos, (3) inert fillers. Particulars of working pressures, temperatures and times are given.

Liquidations, &c.

Claims against the Bosch Magneto Co. (Ltd.), 5, Philpot-lane, London, E.C., are to be sent by April 12 to the liquidator, Mr. H. E. [illegible], [illegible], Carey-street, Lincoln's Inn, W.C.2.

An order was made in the High Court on March 19 for the winding up of the British Hahn Metallic Packing Co. (Ltd.), 24, Basinghall-street, London, E.C.

Companies' Meetings and Reports.

Direct Spanish Telegraph Co. (Ltd.)

[illegible] was held on 26th ult., Sir John Denison [illegible]

[illegible] Freddy having read the notice [illegible]

[illegible] the report [illegible] When I had the pleasure of [illegible] I stated that it would prob[illegible] [illegible] Fund [illegible] expenditure [illegible] Your directors had [illegible]

The report and accounts were adopted, and the dividends and bonus approved. Sir Albert J. Leppoc-Cappell, K.C.I.E., was re-elected a director, and Messrs. Deloitte, Plender, Griffiths & Co. were re-elected as auditors. A vote of thanks to the chairman, directors and staff concluded the meeting.

AUTOMATIC TELEPHONE MFG. CO. (LTD.)—An ordinary general meeting was held last week at Liverpool, Mr. James Taylor presiding. The chairman, in moving the adoption of the report and accounts (abstracted in our issue of 22nd ult.) and the declaration of a dividend on the ordinary shares of 6 per cent., less tax, said it had to be borne in mind that the work done during last year had been almost entirely for the Government. The work done for the Admiralty, the Aeronautics Board and the Post Office was of a class the company would be likely to do after the war. During 1917 they had done a larger proportion of this class of work than during the previous year, and they were trying to develop this as much as possible. Compared with 1916 the output had increased 25 per cent., but owing to lower prices, inflation of labour rates and the excess profits duty the profits shown were considerably less than for the previous year. It would be remembered that a pre-war standard of profit had to be arranged, and, the company having only been in existence a few years when the war broke out, the standard of profits was necessarily a low one. The output from the factory had increased in 1916 and 1917 very largely, but the profit allowed by the Government upon the extra output was a very small one. It was an open question whether the Act would not have some tendency to put a damper on energetic loyalty on the part of manufacturers. Manufacturers were longing to be back to the days of ordinary freedom in business and to be away from the entangled control and officialdom of present arrangements. Owing to export difficulties, the company's foreign trade had had to be largely curtailed for the present. During the war there had been an increasing demand for private automatic installations, an the expansion of this branch of the business had afforded the company the opportunity of demonstrating the advantages of the Strowger automatic telephone for private use. The chairman and Mr. Max Muspratt were re-elected directors.

BRITISH ALUMINIUM CO. (LTD.)—At the ordinary general meeting last week the chairman (Mr A. W. Tait), after dealing with the report and accounts (abstracted in our issue of 22nd ult.), said for some time after the war there would be a period of inflated costs of production and rationing of raw material, due largely to shortage of shipping, but he believed that if industry was freed as far and as quickly as possible from Government interference it would rapidly readjust itself to the altered conditions and make progress because of the lessons learned in the war. There was an enormous field of development for the aluminium industry. Employers were agreed that the men were entitled to better wages, but in return the men must give a better or increased output.

BRITISH INSULATED & HELSBY CABLES (LTD.)—The 22nd annual meeting was held at Liverpool last week. Dr. E. K. Muspratt (chairman) presided, and in moving the adoption of the report and accounts for 1917, said the results were the best obtained by the Company for any year's trading. The output had been almost entirely for the purposes and to the order of the Government, and the directors trusted that the very effective help the company had thus been able to render would not be overlooked or forgotten in the future. They and the great manufacturing concerns in the country must for the prosperity of the nation resume full control of their own affairs at the earliest moment consistent with public safety. The numerous factories established with public money for national purposes during the war might after the war prove their chief competitors for all Government orders and business, and the freedom which they sought in the conduct of their business was necessary in order that those profits might be made which would enable this country to repay the enormous debt which it had contracted in order successfully to prosecute the present war. Doubtless some of the new departments started since the war commenced would help the Company to recover the important position it held before the war, if unfettered by unnecessary Government interference and control, and certainly the company was in as good a position to compete for export business as any manufacturer in the same line in this or any other country. 1,173 of the Company's men had joined the Forces, and 68 had fallen while on active service. The employment of women workers had been greatly increased, with very satisfactory results. The Company's securities were worth more than the figure in the balance sheet. The Company's investments in the Midland Electric Corporation for Power Distribution and in the Automatic Telephone Manufacturing Co. had proved satisfactory, although in regard to those two companies the excess profits tax fell upon them very heavily and prevented them obtaining anything like a just reward for the cost and risk they had undertaken. The point had been reached when further increase of the reserves could not be justified. The dividends paid during recent years had shown a percentage on the ordinary share capital which was misleading to the public, because all the reserves of the Company were employed as capital in the business, and in 1917 the actual capital employed represented more than double the amount of the nominal share capital. The payment of dividends at so high a rate as 25 per cent. gave an erroneous impression that profits on the capital were unduly high. It was therefore proposed, and the consent of the Treasury had been received, to increase the share capital by the capitalisation of £500,000 of the surplus assets out of reserve account and to issue to the ordinary shareholders a further 500,000 shares of £1 each.

The report and accounts (abstracted in our issue of March 22) were adopted, and the dividends set out therein were approved.

Dr. Muspratt and Sir Arthur Stanley were re-elected as directors, and Messrs. Chalmers, Wade & Co. were re-appointed as auditors, and a vote of thanks was accorded the directors.

BROMPTON & KENSINGTON ELECTRICITY SUPPLY CO. (LTD.)—The annual general meeting was held last week, when Mr. H. R. Beeton (chairman), said: Last year in spite of a longer period of "summer time" they sold 12 per cent. more units than in 1916, and gross receipts increased from £55,878 to £61,898. Although they now had nearly 20 per cent. more consumers than they had five years ago they were supplying upwards of 20 per cent. less electricity for lighting, only 5 per cent. of their new custom last year was for lighting, and they now sold not far short of the same quantity of current for accessory purposes as for lighting. The business of the Accessory Co continued to develop, and it was expected that it would become a direct as well as an indirect source of profit. Higher cost of coal and increased wages involved in producing the larger output had been more than compensated for by the economies resulting from more efficient plant and by a large re-adjustment of taxation which accrued to them during last year. It was that fortunate conjuncture of circumstances which had enabled them to resume the payment of the dividend paid for so many years, while making a liberal provision for contingencies. Their prospects of revenue were clouded by the still longer period of "summer time" and by "curfew" restrictions announced by the Coal Controller, and their prospects of expenditure were even more ominous. Deliveries of coal under the contracts they had made for the replenishment of their stocks had been diverted by the Government in favour of less provident undertakers in the metropolis. The wages bill had been increased by Government decisions on the top of voluntary grants beyond all anticipation, and their pre-war scale of wages would be more than doubled in the immediate future. They were therefore compelled to resort to the raising of prices.

CHELSEA ELECTRICITY SUPPLY CO. (LTD.)—The directors' report for year ended Dec. 31, 1917, states that the profit for the year was £35,562 11s. 7d., which, with £3,684 2s. 2d. brought forward and £1,630 15s. 2d. for interest, made a total of £40,877 8s. 11d. After deducting interest on debenture stock £5,480 9s. 2d., interim dividend on preference shares at the rate of 6 per cent, per annum £900, and interim dividend on ordinary shares at the rate of 3 per cent. per annum £3,707 14s., there remains a balance of £30,789 5s. 9d., which the directors recommend shall be appropriated as follows: Reserve for renewals, depreciation and contingencies, £15,670; writing off cost of extinction of founders' shares, £1,089; writing off investments, £1,000; final dividend on preference shares at the rate of 6 per cent. per annum, making 6 per cent. for the year, £900; final dividend on ordinary shares at the rate of 7 per cent. per annum, making 5 per cent. for the year, £8,651 6s.; carried forward, £3,478 19s. 9d. The number of 8-c.p. lamp (equivalents) connected on Dec. 31, was 337,133 (increase 9,605), and units sold were 4,738,672 (increase 467,202 units).

CLYDE VALLEY ELECTRICAL POWER CO.—At the annual meeting last week Mr. F. C. Gardiner (chairman) stated that although there appeared to be a reduction of nearly £10,000 in the profit, full provision had been made for special war taxation, which had not been provided for in the previous year. The contracts for supply showed an increase during the year of 11,882 H.P., and connections to mains an increase of 14,997 H.P.

HADFIELD'S (LTD.)—The profit for 1917 was £257,510 and £185,695 was brought forward, making £443,205. The directors propose to add £100,000 to reserve and renewal account and to carry forward £209,705. In addition to the interim dividend of 1s. per share paid in July last on the ordinary shares, a further dividend of 1s. per share, with a bonus of 1s. per share, tax free, is recommended.

ISLE OF WIGHT ELECTRIC LIGHT & POWER CO. (LTD.)—The directors' report for the year ended Dec. 31, 1917, states that the output for lighting and power was greater than in the previous year, but increased cost of coal and other materials and labour greatly exceeded the increased revenue. Application is being made to the Board of Trade to increase the charges authorised under the Company's Provisional Orders. There was a trading profit of [illegible] [illegible]

LANARKSHIRE TRAMWAYS CO.—[illegible]

LANCASHIRE DYNAMO & MOTOR CO. (LTD.)—[illegible]

LIVERPOOL DISTRICT LIGHTING CO. (LTD.)—[illegible]

winter. Under existing circumstances, the directors recommended a dividend of 3 per cent. for 1917. The report and accounts were adopted, and Mr. F. M. Radcliffe and Mr. Edward Lawrence were re-elected directors.

MIDLAND ELECTRIC CORPN. FOR POWER DISTRIBUTION (LTD.)—The annual meeting was held last week, Dr. E. K. Muspratt presiding. The chairman said the business continued to increase satisfactorily. There were applications in hand for nearly 10,000 H.P., which, if accepted, would necessitate again extending the generating plant. This question and the means of obtaining the necessary capital, estimated at £100,000, was engaging the consideration of the board. The balance of profit was £14,464 better than the previous year. The increases in the charges to consumers were considerably lower than the total increased cost to the company, so that no charge of profiteering could be made against the company. After providing dividends at the rate of 6 per cent. upon both classes of shares, there was £17,453 to carry forward, subject to excess profit duty. The dividend on the ordinary shares is 1 per cent.

NORTHAMPTON ELECTRIC LIGHT & POWER CO. (LTD.)—The accounts for 1917 show that £6,450 has been added to the depreciation account. The dividend on the ordinary shares is the same rate as for the preceding year—namely, 8 per cent. for the half-year, making 6½ per cent. for the year, and £1,668 has been carried forward.

P. R. JACKSON & CO. (LTD.)—The gross profit for 1917 is £21,408, and after payment of debenture interest, &c., and allowing for depreciation and adding amount from 1916, the balance is £15,585, out of which an interim dividend for the half-year to June 30, on the preference shares, and an interim dividend of 2½ per cent. on the ordinary shares were paid in October last, leaving £13,195. The directors now recommend the placing to reserve of £5,670, the payment of the dividend for the half-year ending Dec. 31, 1917, on the preference shares and a final dividend of 7½ per cent. (making 10 per cent. for the year) on the ordinary shares, carrying forward £3,005.

RANSOMES, SIMS & JEFFERIES LTD.—The profit for 1917, after charging depreciation and deducting interest on debenture stock, &c., was £90,027, less preference dividend for 1917 (£11,000), leaving £79,027 which added to £33,809 brought forward makes £112,836. After appropriating £50,000 to reserve, the available balance is £62,836. The directors recommend a dividend on the ordinary shares of 8 per cent. per annum, leaving £36,492 to be carried forward.

RUSHDEN & DISTRICT ELECTRIC SUPPLY CO. (LTD.)—The directors' report states that the number of consumers has increased from 151 to 171 at the end of 1917. The motors increased from 459 to 568½ H.P., of which 358½ is let out on hire. The units sold were 568,207, an increase of 22 per cent. The revenue from sale of current increased from £3,060 to £4,181. The sum of £615 has been added to the depreciation account, and £200 has been written off preliminary expenses. The directors propose a dividend of 5 per cent. for the year, leaving £136 to be carried forward.

SALT UNION (LTD.)—At the recent general meeting the chairman, Mr. G. H. Cox, in dealing with the subsidiary companies, said the demands for electrical energy coupled with the Government's recommendations as to new super power stations, had compelled the Mersey Power Co. to take steps to increase its output. It was hoped that the machinery ordered would be running in a few months. The Mersey Co. had issued capital of £100,000, and the Salt Union had agreed to subscribe for another 1,000,000 £1 shares, while the Government had agreed to grant a loan of £300,000.

SCARBOROUGH ELECTRIC SUPPLY CO. (LTD.)—The annual general meeting was held last week, Mr. C. Alderson Smith presiding. The directors' report, which was adopted, stated that during 1917 there was connected to the Company's mains the equivalent of 1,84[illegible] 30-watt lamps (making a total of 134,387) and the number of units sold was [illegible]. The profit was [illegible], and after paying [illegible] [illegible]

STEWARTS & LLOYDS LTD.—[illegible]

SUNDERLAND & DISTRICT ELECTRIC TRAMWAYS (LTD.)—After [illegible]

TRACTION & POWER SECURITIES CO. (LTD.)—[illegible]

New Companies, Mortgages and Charges, &c.

New Companies.

ACRE STEEL CO. (LTD.) (149,894.) Private company. Reg. March 18, capital £10,000 in £1 shares (5,500 preference and 4,500 [illegible]), to take over the business of a manufacturer and agent carried on by J. S. [illegible] as the Acre Steel Co., and to carry on the business of founders, mechanical, electrical, motor, munitions, and general engineers, motor car builders, &c. Reg. office: 57–9, Long-acre, W.C.

ATTERCLIFFE ENGINEERING & TOOL CO. (LTD.) (149,909.)—Private company. Reg. March 19, capital £2,000 in £1 shares. Metal founders, engineers, boiler makers, wire drawers, iron, copper and steel cable makers, rubber and gutta percha manufacturers and workers, &c. First directors: W. Allen and A. F. Ledger. Reg. office: Ardmore-street, Attercliffe, Sheffield.

BILLINGS & SPENCER CO. (GREAT BRITAIN) (LTD.)—(149,928.)—Private company. Reg. March 21, capital £15,000 in £1 shares, to take over from E. P. Barrus and J. R. Cullen the rights conferred on them by [illegible] Billings & Spencer Co., of Hartford, Connecticut, U.S.A., and to carry on the business of manufacturers of and dealers in [illegible]. First directors: E. P. Barrus and J. R. Cullen.

BOVING ENGINEERING WORKS (LTD.) (149,749.) Private company. Reg. March 1, capital £70,000 in £1 shres (30,000 preference and 40,000 ordinary), to take over the business of constructional engineers, iron-founders and boilermakers carried on by Hartley Caustion & Richmond (Ltd.), and to enter into agreements with Boving & Co. (Ltd.) and Electric Metals (Ltd.). First directors are J. O. Boving, S. D. Lane, C. T. Colpitts, A. Ewing and F. Kear. Reg. office, Imperial-buildings, 56, Kingsway, W.C. 3.

CALGRAY & CO. (LTD.) (149,849.) Private company. Reg. March 13, capital [illegible],000 in £1 shares, to take over the business of manufacturers of [illegible] wares, &c., carried on as Calgray & Co. First directors are E. Calvert and T. J. Grainger. Reg. office, 326, Goswell-road, E.C. 1.

CANONBURY ENGINEERING CO. (LTD.) (149,624.)—Private company. Reg. Feb. 15, capital £4,000 in £1 shares. Ironfounders, mechanical, electrical, constructional, motor and general engineers, &c. Reg. office: 34, Northampton-street, Islington.

ELECTRIC DEPOSITS (LTD.) (10,017.)—Private company. Reg. March 7, capital £5,000 in £1 shares, to carry on the business as indicated by the title and that of engineers, tool makers, &c. First directors are A. Ness, D. O. Mitchell and J. F. Ballantine. Reg. office, 250, Great Western-road, Glasgow.

ELECTRICAL SUPPLIES (LIVERPOOL) (LTD.) (149,569.)—Private company. Reg. Feb. 8, capital £2,000 in £1 shares, electrical and mechanical engineers, manufacturers of and dealers in electric, telegraphic, telephonic and other appliances, &c.

KNOX MFG. CO. (LTD.) (149,481.)—Private company. Reg. Jan. 29, capital £2,000 in £1 shares, mechanical, chemical, electrical and [illegible] engineers, electricians, wire drawers, japanners, enamellers, &c. [illegible] J. Knox and C. N. Knox.

MEDICAL SUPPLY ASSOCIATION (LTD.) (149,598.)—Private company. Reg. Feb. 12, capital £10,000 in £1 shares, manufacturers of and dealers in [illegible] apparatus, X-ray and electro-medical [illegible]. First directors [illegible] E. T. B. Greville, Mrs. S. Greville (permanent), Capt. E. R. G. Greville, R.A.M.C., and Mrs. E. [illegible]. Reg. office: 167, [illegible], W.

METALLIC ELECTRICAL ENGINEERING CO. (LTD.) (149,515.)—[illegible]

[illegible]

[illegible]

[illegible]

Mortgages and Charges.

ALLEN WEST & CO. (LTD.)—Particulars of £25,000 debentures created March 11, 1918, filed pursuant to Section 93 (3) of the Companies (Consolidation) Act, 1908, the whole amount being now issued. Property charged: the Company's undertaking and property, present and future, including uncalled capital. No Trustees.

BASTIAN ELECTRIC CO. (LTD.)—Particulars of £2,000 debentures created Sept. 3 and secured by trust deed dated Nov. 12, 1917, have been filed. None of the debentures have been issued at present. Property charged: Leasehold hereditaments at 185, Wardour-street, W., and company's other assets. Trustees: R. H. Forman and R. G. Warner. Issue on Jan. 21, 1918, of £400 debentures, part of series of which particulars have already been filed.

ELIESON ELECTRIC TRACTION CO. (LTD.)—Debenture dated Jan. 18, 1918, to secure £225 and further advances up to a total of £400, charged on Company's undertaking and property. Holder: C. P. Elieson.

IMPERIAL UNITED LAMP CO. (LTD.)—Mortgage dated Jan. 24, 1918, to secure £11,000 and a bonus not exceeding 10 per cent., charged on land at Osmaston, Derby, and the Company's undertaking and general assets.

SIEMENS BROS. DYNAMO WORKS (LTD.) — Debenture dated Feb. 1, 1918 (as collateral security for £690,000, part of £1,300,000 debenture stock secured by trust deed dated Jan. 15, 1918), charged on Company's undertaking and property, including uncalled capital (subject to £200,000 debenture stock covered by deed of 1907).

City Notes.

BOMBAY ELECTRIC SUPPLY & TRAMWAYS CO. (LTD.)—A dividend on the ordinary shares of 10 per cent. for the year 1917 (with a bonus of 4 per cent.) is announced. For the previous year the dividend was the same, but without a bonus.

CROMPTON & CO. (LTD.)—This Company is making an issue of £150,000 6 per cent. first mortgage debentures at £95 per £100 debentures. The new issue will replace the existing £100,000 5½ per cent. debentures.

SUBMARINE CABLES' TRUST.—The coupon due on the 15th inst. will be paid by Messrs. Glyn, Mills & Co., 67, Lombard-street, E.C., between 10 a.m. and 2 p.m.

PARA ELECTRIC RAILWAYS & LIGHTING CO. (LTD.)—It is announced that owing to the delays in mails the audited accounts from Para have not yet been received, and the report for the year ended Nov. 30 last and the payments of the usual dividends on the preference and ordinary shares have to be postponed.

The Round Table.

By "kVA."

The Hun "mystery" gun continues to occupy the already limited space in our rationed newspapers. The "Daily News" however, provides the *crème de la crème* of the arguments:—

"An electrical expert, with a number of ingenious inventions to his credit, demonstrated yesterday in London his reasons for believing that the German "mystery gun" is an electrical contrivance. He performed an experiment with two low-power dry batteries, an ordinary wired bobbin, and a large French nail. The nail, lying across a couple of pencils to lessen friction in motion, was placed with one end just within the bobbin and, a current was run through the coil. The result was that the nail was drawn with great force into the bobbin, until held there by the current. If the current were cut off almost immediately the circuit was completed, the nail was thrown forward through the bobbin into space. If for the bobbin you substitute an electrifiable gun-barrel of great length, divided into a number of sections independently wired, and if you replace the nail by a projectile, at the same time providing adequately powerful batteries, it should be possible to develop enormous muzzle velocity by electrifying one section of the barrel after another in turn, the current being automatically cut off each section [illegible] and given sufficient impetus to the projectile to carry it to the [illegible]."

[illegible] an article on concrete ships, and "The Star" [illegible] says:—

[illegible] of the promised concrete ships is due to the fact that the [illegible] shipbuilding programme is still in the abstract.

* * * *

Thirty-Seven Years Ago.

[From The Electrician, April 2, 1881.]

Electric Light in Paris.—M. Dandigny has just petitioned the Municipal Council of Paris for leave to establish an electric light in the Place de la Republique. It will be supplied by a steam engine of [illegible], and diffused by a reflector of his own invention.

Swan's Light in Coal Mines.—The Swan electric light is, we learn, to be "laid on" to Mr. John Watson's Earnock Colliery, Motherwell, and will extend to the pit bottom, the roadways, the station where the underground engine is placed, and possibly the miners' working places. Mr. Watson is of opinion that the lighting of the coal pit by electricity is both feasible and practicable, and he has determined to put his opinion to the test. The result will be looked forward to with the keenest interest by all connected with the coal mining industry.

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

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CONTENTS.

Notes.

American Methods.

UNDER the heading "Further Notes on American Methods of Handling and Storing Iron Ore and Coal" elsewhere in this issue will be found an account of certain machinery and methods in use in America for the efficient handling of the vast quantities of the raw material of American industries. Although a section of the Ministry of Munitions is said to be dealing with all matters relating to the handling of materials, with few exceptions there has been no marked improvement either in our machinery or methods in recent years. Those who use the railways have become familiar with the archaic methods of coaling locomotives used by the principal railways, and with the primitive methods of handling the enormous coal stocks held by the railways. These are given as typical examples of what may be called our conservative policy. Those whose misfortune it is to use our waterways have, in many cases, to be content with the hand-winch method of unloading material from barges because of the railway companies' interest in the said waterways, and because a very small section of the community calling itself the "Amalgamated Society of Something or Other" holds that modern machinery displaces manual labour. We read of coal wagons of 100 tons capacity being put into commission on the American railways, and on looking into the matter find that at some of our principal ports average loads are less than one-twelfth of this amount. Fierce discussions have taken place at our engineering institutions on the unsuitability of electricity as a motive power for the driving of dock appliances, and [illegible] of the "Proceedings" [illegible] account either of [illegible] electrically driven machinery, or of a record in handling which has made American industry what it is to-day. [illegible] handling business in America and of the distances to be covered in getting together the raw materials of industry, and in distributing the finished product, was given in Mr. G. H. Hutchinson's recent [illegible] in these columns. As surely as American methods made her steel trade what it is in the markets of the world, as surely will similar methods give her a similar position in the export coal trade when she desires to engage in such trade. And as surely do the Americans deserve the position which they occupy.

Labour in the United States.

LAST week an important agreement was announced, binding both masters and men in the United States to refrain from strikes and lock-outs during the war, and to submit disputes to a Government mediation body. The employers are to take no exception to unions, nor are the workers to use measures of a coercive character. The eight-hour day is recognised in all cases in which the existing law requires it, and in other cases the hours of labour are to be settled with due regard to Government interests and the welfare and proper comfort of the workers. Maximum production of all war industries is to be maintained, and methods tending to delay or limit production or to increase the cost are to be discontinued. That such an agreement should be reached so quickly may, perhaps, be taken as an indication that the true state of affairs has been realised more quickly in the United States than it was for some time in this country. Also it may possibly mean that there is a better appreciation on the part of the workers in the United States of the claims of capital and a greater disposition to work amicably with the employer. These, however, are still early days for the United States. It will be admitted that the labour leaders in Great Britain have been very willing to assist the Government in every way by following the dictates of common sense. Trouble, however, has arisen, not from the leaders, but from the irresponsible rank and file. It remains yet to be seen whether the rank and file in America are prepared to follow their leaders and to give whole-hearted co-operation, or whether difficulties will yet arise. In any case, further developments will be watched with more than usual interest in this country.

Science in War.

OUR attention has been drawn by Sir ROBERT HADFIELD to a significant action by the KAISER in approving the foundation of a trust which is to be entitled "The Kaiser Wilhelm Trust for the Promotion of War Science." The aim of this organisation is to further the development of scientific and technical aids in warfare by uniting the scientific and the military forces of the country in co-operative effort. The work is to be carried on by committees dealing with (1) chemical raw materials for the production of materials for munitions; (2) chemical war materials and appliances; (3) physics, including telegraphy and telephony; (4) engineering and communications; (5) aeronautics; and (6) the obtaining and preparation of metals. We think it will be generally agreed that [illegible] is likely to be [illegible] than [illegible] followed in this country, and that [illegible] desirable in Germany it is still more likely to be necessary in Great Britain. We are well aware that certain similar efforts are already carried on in one way or another by our Government departments, but we very much doubt if full advantage is yet being taken of the technical and scientific ability of this country up to the present time.

Fuel Economy and Private Plants.

The restrictions on lighting must have led many people to wonder whether there are not other opportunities for economy in fuel which would prove more effective and would cause less general inconvenience. Among such measures is the substitution of supply from a central station for inefficient private plants. We are aware that it is difficult to draw a hard and fast line. For example, in the discussion of Mr. Pearce's recent Paper on "Electric Power Supply and Coal Conservation," which is dealt with in this issue, a case was mentioned by Mr. T. R. Wollaston where a private plant was apparently able to manufacture electricity for its own use at less than 0·3d. per unit. This was ascribed to the good load factor but pre-supposes an efficient use of coal. Generally speaking, however, there are many private plants in operation which are very inefficient in this respect. The question whether, in the interests of coal economy, private electric plants should not be closed down and energy taken from central stations, is now receiving the attention of the New York Public Service Commission. According to various opinions expressed before the Commission considerable savings in coal might be made as a result of such a step. Mr. J. W. Lieb estimated that if all the 650 private plants in Manhattan and the Bronx were closed down and energy taken from the electric corporations, a saving of 500,000 or possibly 838,000 tons of coal per annum might be made. Representatives of the United States Fuel Administration will attend future hearings of the Commission. According to reports made to the Administration the possible saving throughout the entire country would amount to millions of tons, apart from the relief to transport, cartage and traffic [illegible]

Precision and Style in Scientific Terminology.

The [illegible] and language of writers on scientific and technical subjects have not infrequently been a subject of reproach by literary men, and the tendency to "jargon," which is, perhaps, inevitable in the development of any new science brings with it various uncouth phrases. At a recent meeting of the Académie des Sciences objection was taken to a number of phrases in common use, particularly those which result from too literal translation and become invested with a significance which they did not originally bear. In mathematical science new expressions are rare, and the construction in general correct. But electrical science is a frequent offender. Objection is [illegible] "[illegible]" and "mutual" as applied to induction. Similarly the word "control," when applied in [illegible] is invested with a wrong significance. Such mis-translations lead to confusion. Among [illegible] "adsorption" is considered [illegible] "[illegible] adsorption" and [illegible] veritable barbarism" [illegible] technical men will feel [illegible]

[illegible]

Sampling of Coal for [illegible] of Delivery.—A [illegible] [illegible] by the Bureau of Mines, Washington, [illegible]

Wire Gauges.—The Bureau of Standards (Washington, D.C.) has issued Circular 67, giving a combined table of sizes in the principal wire gauges.

The table combines in one series the sizes in the American (B. & S.), Steel, Birmingham (Stubs'), British Standard, and Metric Wire Gauges, arranged in order of diameters of wires. It gives the diameters of all the gauge numbers in the five systems, in mils, inches and millimeters, also the cross-sections in square mils, circular mils, square inches and square millimeters. Those interested may obtain a copy of the circular from the Bureau.

Institute of Metals.—The report of the Council of the Institute of Metals for the past year contains evidence of further progress. The membership has increased by 34 per cent., largely as the result of the activities of members in Sheffield and Birmingham, and a useful series of Papers has been read during the session. The resources of the Institute have been freely placed at the disposal of the section of the Ministry of Munitions concerned with non-ferrous metals. Research is still being conducted by the Corrosion Research Committee, with the assistance of funds contributed by the Department of Scientific and Industrial Research, and a grant has also been made by the British Electrical and Allied Manufacturers' Association. Among the matters under consideration is the corrosion of condenser tubes by fresh water.

Correction Factors for the Pentane Lamp.—A report by Messrs. K. Takatsu and M. Tanaka, issued from the Electrotechnical Laboratory, Department of Communications, Tokyo, states that in Japan the unit of light is now defined as one-tenth of the luminous intensity of the 10 c.p. Pentane standard. The authors give an analysis of previous investigations of corrections for this lamp. The water-vapour correction agrees closely with that deduced by Paterson at the National Physical Laboratory, but differs somewhat from that obtained by Crittenden at the Bureau of Standards. This may be due to the fact that the climate of Japan resembles that of England more closely than that of the United States. But a more probable explanation of the discrepancy seems to be the fact that a special ventilating hood was used with the lamp at the Bureau of Standards. Experiments in Tokyo have shown that the use of such a hood has a material influence in causing a diminution in the light, and possibly affecting correction errors. It seems desirable to establish uniformity of practice in this respect.

High Candle-Power Projection Incandescent Lamps.—A good deal of work on the design of incandescent lamps for projection work has recently been carried out. According to a recent contribution by Mr. O. Kruh, in "Elektrotechnik und Maschinenbau," it has now been found possible to make lamps taking up to 200 amperes, and giving 30,000 to 40,000 hefner candles, while even 100,000 candles is considered practicable, the chief limit being the size of the lamp-bulb. The great difficulty hitherto in constructing such high candle-power lamps has been the leading-in wires. It is not easy to secure an air-tight joint for such high currents, but according to the author this can be done by a special method, which, however, he does not disclose in this article. Such lamps work at about 0·25 watt per candle (hefner). The filaments are mounted in the form of straight bars, as close together as possible, and their useful effect is increased by the use of concave mirrors behind the filaments, the latter being at the centre of curvature of the mirror. The mirror can be so adjusted that the [illegible] of the filaments completely fills the interstices between them. We have thus a practically homogeneous source, the intrinsic brilliancy of which, it is contended, closely approaches that of the carbon arc crater.

The Lighting of the Great Barrier Reef.—A Paper on the [illegible] was recently read by Mr. J. F. Ramsbotham, [illegible] of Lighthouses to the Commonwealth of Australia, [illegible] the Liverpool Engineering Society. The author discussed in some detail the physical conditions prevailing in the Great Barrier Reef, which forms a natural breakwater about [illegible] long [illegible] the entire eastern coast of Queensland. [illegible] of reef formation have been [illegible] some of the lights were mounted

on coral reefs special consideration had to be given to the intensity of stress that coral is capable of withstanding, the necessary depth of the foundation, and the influence of wave action. The measures taken in preparing the foundations were described in some detail. The "unattended" lights used are of the "Aga" flashlight acetylene type, those of 1,500 c.p. being visible at 13 miles, while those of 5,000 c.p. can be seen at nearly twice the distance. In concluding his Paper, the author recalled that both he and the late Lieut. Ridgeway, who was associated with him in this work, but was killed at Gallipoli, originally worked under Mr. A. G. Lyster, engineer-in-chief to the Mersey Docks, and both took a keen interest in the Liverpool Engineering Society.

Rontgen Society.—Last Tuesday Sir Ernest Rutherford delivered the first Silvanus Thompson memorial lecture before the Röntgen Society. The lecturer first referred to the fact that Prof. Thompson was the first president of the Röntgen Society, and was very interested in X-rays. The same day as the discovery of these rays was announced in "The Times," Prof. Thompson succeeded in taking a radiographic photograph in the evening. Passing on to the subject of his lecture, Sir Ernest remarked that the progress of X-rays showed the extraordinary advance that was possible by a combination of hypothesis and experiment. The subject that received the most immediate attention was the investigation of the origin of the rays and the discharge of electricity through gases, and from this work came the discovery of radio-activity and the electron; this was followed by a greatly increased knowledge of ionisation and the emission of negative ions from hot bodies. Initially there was the idea that X-rays might be due to phosphorescence, and many experiments were made in this direction. A positive result was at length found by Becquerel, who obtained photographic effects from a compound of uranium and potassium. This result was not at first correctly interpreted, but it was followed in due course by the work of the Curies, and this led in due time to discovery of a number of elements for which it became difficult to find a place in the Periodic Table. This matter was cleared up by an hypothesis put forward by Soddy and others simultaneously. Barkla made the important discovery that substances could be made to give characteristic radiations when stimulated by X-rays, and this work was followed by that of Bragg and his son on the structure of crystals and by Moseley on the constitution of elements expressed in terms of the atomic number rather than the atomic weight.

Substitutes in the German Electrical Industry.—An article in "Engineering" gives some interesting particulars of the substitutes being adopted in the German electrical industry as illustrated in a Paper before a meeting of Swedish electricity works by Mr. M. T. Husberg. Early in 1914, copper, rubber and other raw materials were commandeered by the German Government. The shortage in copper and its alloys has perhaps been the greatest difficulty. [illegible]

proposed for composite conductors (*e.g.*, galvanised steel with an outer layer of zinc). Overhead lines of zinc alone are not likely to be used. Machines with substitute metals naturally have a relatively low efficiency, the efficiency of direct current machines with zinc windings and iron commutator being given as 50 per cent., while transformers with zinc windings are credited with 60 per cent. Recently aluminium has been more generally used for machine windings, but even so an efficiency about 20 per cent. below that of a machine of similar type with copper windings is experienced.

Obituary.

GEO. H. CARTER.—The death is announced of Mr. George Herbert Carter, formerly electrical engineer of the Heckmondwike Urban Council electricity works.

F. W. STREATFIELD.—The death is also recorded of Mr. F. W. Streatfield, late superintendent of the chemical laboratories at the Finsbury Technical College.

J. S. BRODIE.—The death is also reported of Mr. J. S. BRODIE, borough engineer of Blackpool.

DEATHS ON ACTIVE SERVICE.—The following deaths on active service are reported:—

Capt. Bernard Wm. Arnold, R.F.A., aged 23, who was killed on March 21, was formerly an engineering student at University College, London.

Lieut. Geo. Kenneth Steinberg, M.C., M.G.C., who was killed on March 22 in his 25th year, was educated at University College School, London, and was afterwards employed in the British Thomson Houston Co.'s Patents Department.

Personal.

Mr. Joseph Rippon, of the Bermuda cable companies, and chairman of the Bermuda Contingent Committee, has been awarded the O.B.E. for services in or for the overseas dominions, colonies and protectorates in connection with the war.

Señor Don Francisco P. Arrillaga y Gatto has been appointed Director-General of Spanish Posts and Telegraphs, in succession to the Duque de Bivona, resigned.

Arrangements for the Week.

FRIDAY April 12th (to day).

ROYAL INSTITUTION.

5.30 p.m. At Albemarle-street, Piccadilly, London, W. 1. Discourse on "Phosphorus and Phosphorescence," by Prof. E. C. C. Baly, F.R.S.

JUNIOR INSTITUTION OF ENGINEERS.

7.30 p.m. At 39, Victoria-street, London, S.W. 1. Lecturette on "Steam: Its Properties and Production," by Mr. R. H. Parsons.

SATURDAY, April 13th

BIRMINGHAM AND DISTRICT [illegible]

[illegible]

MONDAY, April 15th.

[illegible]

TUESDAY, April 16th

[illegible]

WEDNESDAY, April 17th

[illegible]

THURSDAY, April 18th.

[illegible]

FRIDAY, April 19th.

[illegible]

Electric Power Supply and Coal Conservation.

In our issue of the 29th ult. we gave in abstract the contribution of Mr. S. L. Pearce to a discussion on this subject. We are now able to give some account of the discussion which ensued.

Mr. Selvey confirmed certain very important conclusions of Mr. Pearce. He had some data relating to the transmission of 100,000 kw. to distances ranging from 10 to 40 miles with high tension. As regards the ideal site with unlimited cooling water, cables at 40,000 volts and cheap coal, he estimated that at 30 miles the net cost of power delivery was increased by 20 per cent. The report was very cautious; there was nothing an engineer could put his finger on and say, " This is a case I can test with the knowledge I have acquired in the business of power production." What then was the report? It was really an essay on Government control or company control, and followed familiar lines. At the end three forms of Government were suggested. The first was a paternal or benevolent autocracy—a trust. The second scheme was Government Commissioners, which meant bureaucratic government by a small number of permanent officials. The third form of Government was devolution or decentralisation in which the local administrative work was carried out by permanent officials controlled by local representatives, the whole being controlled by a deliberate law-making elective body, which acted through permanent centralised officials having purely administrative functions. That was similar to what obtained before the war, but the trouble was that the engineers and permanent officials were not suitably selected nor had they adequate power to make a scheme a thorough success. In Government circles contempt was expressed for the middleman; yet it had been found necessary to create a number of departments in London to act as such in order to carry on the war. In one important matter—food control—the Government Department, in its rôle of middleman, had absolutely broken down. Food was perhaps more essential than electricity, but the underlying principles were much the same. To deal efficiently with the question of electricity the Government would also have to come to the local authorities. The argument in favour of the trust was freedom of range and efficient working, but it had obvious drawbacks. The objections to the second form of Government—the centralised Government Department—were less serious, assuming that the Commissioners would be selected from men of known probity with wide engineering, legal and financial experience. But it was highly objectionable in the case of a young growing industry. The third form was decentralisation into areas Here he was in agreement with Mr. Pearce, but he thought the question had been dealt with on narrow lines. The municipal community must extend, a local committee must take over a whole district and electricity should be dealt with along with water, gas, traction and transport, in each of those local districts. The report laid stress upon the analogy of railways. He thought the analogy was a false one, but even so, the railways had failed when it came to questions of local distribution. After the war they would see an enormous increase in road transport within any given municipal area. The report also seemed to assume that the last word had been said on the scheme under which electricity was produced. Once they got those super power-stations and electrical roads, there would still be development Under the very best rated engine they could never convert, on the Rankine cycle, more than about 30 per cent. of the heat in the steam into mechanical work. 70 per cent. of the heat they got into the steam was thrown away; all that the super-heat [illegible] a little less than the 70 per cent. He [illegible] per cent. [illegible] heat. For manu-[illegible] high grade heat at high temperature [illegible] had been turned into an available form. The bulk of the [illegible] to keep up continuously [illegible] To-day they were producing [illegible] for that purpose, and [illegible] that they were destroy-[illegible] the low grade heat. [illegible] station [illegible]

[illegible] plant [illegible] years. But in Manchester developments in electric power supply [illegible] taken a shorter period as the probable life of the plant and created an extra sinking fund, beyond the legal sinking fund. There were other reasons for municipal control within a municipal area. In a distribution scheme there must be a constant disturbance of the public streets. Other departments, such as water and gas, also had their systems of supply, and if electricity was controlled by a separate authority it would lead to friction, such as existed in the days of the telephone companies. The various departments now worked hand in hand, through a " clearing house." This procedure prevented one department operating independently of the others. Municipalities would consider favourably and come into any scheme that would remove the parish boundary idea and place an ample and cheap supply of electricity at the disposal of all industries within or outside the boundary. With the exception of one municipality all the companies and municipalities in Lancashire had a standard system; a periodicity of 50, 3-phase, 6,600 volts generation, which showed how easy linking up would be. Linking up alone must not be looked upon as the solution of the problem. The conservation of coal was also a necessity, and the importance of having ample supplies of water for condensing purposes had been constantly emphasised. At Barton there was no need to use cooling towers; the supply of water was ample for the purposes of the super-station of, say, 120,000 kw. to be installed. Therefore, the Manchester area could congratulate itself upon being in a favourable position. The utilisation of heat from a central power had been done in Manchester to some extent. Large blocks—including the Calico Printers' Association Building—were to-day heated by the waste steam from the city station of the Corporation.

Mr. A. Saxon said Mr. Pearce had advised caution in connection with the installation of the proposed super power stations. Would not the engineering resources of the country be better employed when the war was over in developing foreign trade with the materials which would then be available, rather than attempting to establish economies in the proposed super power stations? Some of the expected savings were doubtful. The engineering section of the community must consider whether they could best serve the interests of the country by attempting to save a little coal or recovering foreign trade.

Mr. Drummond Paton said that coal conservation was not a new subject. Under the present system it was impossible to handle bastard cannel coal, but it could be utilised by means of low temperature distillation. It was quite possible thus to produce 750,000 h.p. per day, and it would not involve any interruption of the present supply. In the home area they had cannel coal which compared satisfactorily with the oil-producing material utilised in the plants in the West of Scotland.

Mr. T. R. Wollaston said the information embodied in the Report was largely derived from the N.E. Coast experience, but there was no real basis of comparison with the Lancashire district. The main reason for that was the load factor. The Report implied that if the price of the current was ½d. per unit that would bring in practically every industry. This was not correct. In cotton spinning and weaving, power was obtained at a price considerably less than ½d. per unit. The same applied to a flour mill or an electrochemical place working with practically 100 per cent. load factor. Four miles from that building there was a spinning mill which got a public supply at a price which he had reason to think was about 0·3d. per unit. Yet that concern put down their own power station and stated that they were doing better. Therefore factories with anything like a good load factor would want a lot of persuading. On the question of super stations and economy he believed the coal cost, in proportion to the total cost of current, was comparatively small—a third to a quarter—so that the saving in that respect effected by the super stations would not be large; it would be 30 or 25 per cent. of the cost of current. He agreed that they had not reached finality at present. Super stations put up to-day would be obsolete in 10 years. By-product recovery was a complex subject. Experiments should be tried on a small scale at first. There was a lot to learn in connection with existing stations. The great difficulty was finance, but in the modern stations with enterprising men at the head there was a possibility of experimenting and finding out what by-product recovery would really do for them.

Mr. Allcock said the Report had been presented to the Ministry of Reconstruction. It contained three very tempting promises, namely, [illegible] 000,000 tons of coal per year, the corresponding amount of transport at a time when transport will be at a premium, and con-[illegible] aggregating about £100,000,000 per annum. He suggested that Mr. Pearce's address might be printed and submitted to [illegible] Committee, so that they would then realise that [illegible] to the question. A carefully thought out criticism of the Report would show the Reconstruction Committee that there were several striking features in regard to which they were in agreement. [illegible] they were prepared to say that the municipal boundary [illegible] be the boundary of electricity supply. That was an enormous step forward. Another point on which he gathered Mr. Pearce [illegible] the Report was the question of linking up. That, again, [illegible] Reconstruction Committee to have at their disposal [illegible] electricity supply.

[illegible] that they would all agree a prima facie case was [illegible] It was a question of carrying [illegible] the Report being [illegible] the supply in bulk from super power [illegible] where local authorities [illegible] widely outside their own

district. Power companies were inaugurated and financed from London and they were treated with suspicion in the districts in which they operated. For instance, in Lancashire nine-tenths of Bolton were cut out of the area altogether. They could not take any area without the consent of the local authority. The Government of the time had not the courage to back up the power companies in the powers given to them, so that the power companies were at a disadvantage from the day they started. He wished to emphasise Mr. Pearce's suggestion that there should be a super Control Board in London which should have the decision when local authorities and companies differed.

Dr. CRAMP called attention to the fact that on the following day the Manchester City Council would be asked to sanction a recommendation that the surplus profits of the electricity undertaking be paid over to the City Fund in relief of the rates to the extent of 1 per cent. on the capital expenditure.

He moved the following resolution :—

"This meeting of Engineers, convened to consider the Report of the Fuel Conservation Sub-Committee of the Reconstruction Committee, agrees that ample and cheap supplies of electricity are essential to the future industrial development of the nation. Holding these views they have noted with alarm a recommendation which is to be made to the Manchester City Council by the Trading Profits Special Committee, to the effect that the actual surplus profits of the Electricity Department be paid over to the City Fund, with a fixed minimum of 1 per cent. upon the aggregate capital expenditure of the electricity undertaking. They regard this proposal as unfair on the undertaking, unjust to the consumers, and unwise for the community and they call upon the City Council to refuse to accept it."

This recommendation was unfair to the undertaking, because it already bore a much heavier charge for depreciation than was paid by other undertakings under company control. Secondly, it called upon them to pay not any proportion of working capital or invested capital but a proportion of the whole of the capital that had been spent from the beginning, whether paid off or not. The total capital expenditure spent on the Manchester electricity undertaking was about £3,500,000 and £1,600,000 had been repaid by the ratepayers or consumers. They were to pay 1 per cent. on that. Why? Because it looked like 1 per cent. instead of 2 per cent. on the remainder. The third point was that it was unjust to the consumers because if the price was not actually raised to them it would prevent the price going down. And the best consumers were those who had large works in the immediate district. The proposal was unfair and unjust to the consumer. It was also unwise from the point of view of the community. Smoke and fog would disappear if electricity took the place of coal, and for that reason it ought to be supplied cheaply. The recommendation would hinder the normal growth of the industry.

Mr. [illegible] in seconding the resolution, said the subject came before the Engineering and Metals Section of the Manchester Chamber of Commerce [illegible]

The resolution was carried unanimously.

Tests on Oil Switches.

In an appendix to Dr. C. C. Garrard's Paper, read before the Institution of Electrical Engineers, are given some interesting tests on the speed of operation of oil switches. A number of tests were made in the power house and sub-stations of a Midland city in order to obtain the necessary information.

FIG. 1.—APPARATUS FOR DETERMINING SPEED OF BREAK OF OIL SWITCHES.

The apparatus used is shown in Fig. 1. This consists of a rotating drum with a pencil mechanically connected to the moving portion of the switch. At the bottom of the drum two traces are made, one by a tuning fork vibrating 50 times per second, and the other by a marker connected across the trip coil. The latter thus shows exactly when the tripping circuit is made, and the tuning fork gives a time scale.

Fig. 2 shows the kind of result obtained, and is a record of a 200-ampere 5,000-volt switch having a brush contact. It shows that the effect of the oil on the speed is very small. It will be noticed that

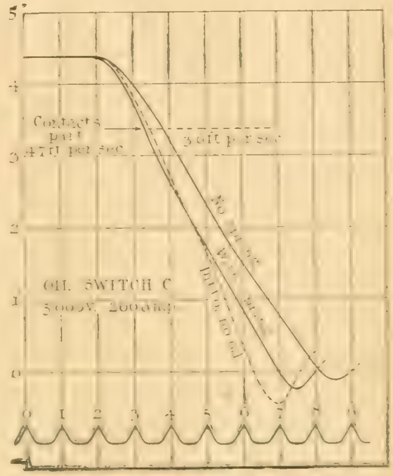


FIG. 2.—SHOWING EXAMPLES OF RESULTS OBTAINED.

with the spring in action the contacts part at the rate of 4·7 ft. per second, and after this speed has been reached it remains practically constant during the rest of the movement. Without the oil the initial speed is 3·6 ft. per second, and if the spring is not used the speed is lower.

New Forms of Prepayment Switches.*

By F. BIERMANN.

[illegible]

* [illegible]

Elementary Principles of Continuous-Current Armature Winding.

By F. M. DENTON, A.C.G.I.

(*Continued from page* 833.)

Summary.—Continuous-current armature windings are first classified, the nature of the various classes of winding is then explained, and special terms used are defined. The derivation of the usual winding rules is developed by a simple method based upon an understanding of the ordinary Gramme ring. The rules derived apply to multiplex windings as well as to simplex. The use of multiplex windings is discussed, and reasons are given for the avoidance of their use. The simple theory of equalising connections is explained and rules are derived for the application of such connections. Chord winding is explained, followed by the use of interpolated commutator segments, and, finally, special consideration is given to the question of the number of slots that should be used for a given winding, taking into account the inductance of the parallel paths. The article concludes with a schedule of winding rules.

MULTIPLEX WINDINGS.

The Use of Multiplex Windings.—The cell diagrams show (*see*, for instance, Figs. 18, 19 and 20) that a simplex lap winding has p paths in parallel, whilst for all values of p a simplex wave has but two paths. When the designer's choice is restricted to these two types he sometimes finds that whereas from the point of view of current per armature bar, the two paths of a wave winding are insufficient, the number of poles, which, for other reasons than current output, he would like to use, gives him, with a lap winding, more paths than are desirable, compelling him to use many turns of thin wire. The possibility of using a number of paths intermediate between 2 and p would enable him to employ fewer turns on the armature, and so obtain a better space factor (since the thickness of insulation upon each conductor will be the same whether there be few conductors or many). The multiplex wave (series parallel) winding puts at the designer's disposal four, six, eight or any even number of parallel paths irrespective of the number of poles (p). Thus, a 12-pole machine intended for an output of 500 amperes, which with a lap winding would have an armature current of only 41·5 amperes per bar, might be given a series parallel winding (either duplex singly or duplex doubly re-entrant according to the precise number of slots and bars it is desired to use) having four paths in parallel, the armature conductors each carrying 125 amperes.

If, for instance, the winding were required to have about 300 to 350 coil sides ("bars" in our nomenclature) we might obtain a duplex singly re-entrant wave by taking

$y = 27$ and [illegible] 12×27 [illegible] 320.

[illegible] 27 [illegible] G.C.F. of 27 and 2 = unity.

In order to obtain a duplex doubly re-entrant winding (OO) we might choose [illegible]

[illegible] 27 and [illegible] 12 [illegible] $= 316$ or 308, [illegible]

If for any reason six paths in parallel were required, use might be made of a triplex (singly or trebly re-entrant) wave winding. Such a winding would be satisfied by the following choice of bars and pitches:—

Trebly Re-entrant.

[illegible]

Singly Re-entrant.

[illegible]

[illegible] sufficient, since 1,000 amperes per brush is excessive on account both of commutation and of the mechanical difficulty of designing sufficiently rigid brush gear. Eight paths would simplify the design, and this number of paths would be obtained by using a duplex lap winding. If the number of slots to be used were 100, giving, with two coil sides per slot $z = 200$, we might take

y = about 200/12 = about 17. y_f and y_b differ by $2m$, *i.e.*, by 4.	$y_f = 15$, $y_b = 19$, r = (G.C.F. of $z/2$ and m) = 2. To get a singly re-entrant winding we might take $z = 198$ or 202.

In the numerical examples just given no account has been taken of the special rules which have to be followed in practice to ensure satisfactory commutation.

SPECIAL RULES THAT SHOULD BE OBSERVED IN DESIGNING SERIES-PARALLEL WINDINGS.

Multiplex wave (series parallel) windings, of which a simple example has just been given, deserve special attention. The commercial development of such windings was begun at Oerlikon by E. Arnold in 1891, and was later taken up chiefly by the Lahmeyer Company, of Frankfort. In Arnold's book, "Die Gleichstrommaschine," Vol. I., a complete discussion is given of all types of armature windings for continuous-current machines and especially of the series-parallel type, whilst in Vol. II. of the same work a dozen instances are given, with the main design details of commercially successful machines varying in output from 100 kw. to 1,300 kw. equipped with series-parallel windings. One machine, for instance, is rated 500 kw. 12-pole 212 revs. per min. 230 volts 2,175 amperes, and has a 12-plex series-parallel winding, whilst another is rated 1,320 kw. 18 pole 95 revs. per min. 145-volt 9,100 amperes, and has an 18-plex winding.

In view of this considerable commercial success with machines having series-parallel windings it seems remarkable that to-day some of the leading European as well as American firms are careful to avoid this type of winding. The reason appears to be, not that such windings when carefully designed give trouble, but rather that any advantage which they may have over the simplex lap-winding is not great enough to warrant the special care and thought in design and manufacture which their use entails.

A simplex lap-winding is easy to lay out, is by its nature symmetrical and can readily be provided with a simple and effective system of equalising connectors, whilst, on the other hand, a series parallel winding demands careful design if unsymmetry is to be avoided, and has a less effective equalising system. Given the most careful design, the series parallel winding with p brushes has not the same automatic tendency towards equal distribution of load between the brushes that is inherent in a lap-winding.

A multiplex wave winding has $2m$ parallel paths, and it is essential that each path shall contain the same number of bars [illegible]. Hence in such a winding z must be divisible by $2m$—that is to say, $z/2$ must be divisible by m, or, since the number of commutator segments K is equal to $z/2$, and in a wave-winding [illegible] we may write [illegible] $K \div (a/2.)$ Thus, the rule for ensuring symmetry in a series parallel winding is that K, the number of commutator segments, shall be divisible by half the number of parallel paths in the winding.

This condition demands that p shall be divisible by a, for we know that, for a wave winding, pq [illegible] $2m$—*i.e.*, pq $2m$ [illegible] $2m$ ± 1, and as $z/2m$ must be made a whole number it is evident that pq $2m$ and so also (except in the case in which p is less than $2m$) $p/2m$ must be a whole number. But in a wave winding $2m=a$ and the condition becomes that p shall be divisible by a.

Thus, a singly re-entrant winding, in which p is divisible by a will be symmetrical, and since the symmetry will be unaffected by the addition of any desired number of re-entrant sections similar to the first it follows that a multiplex series parallel winding of any degree of re-entrancy *will be symmetrical provided the number of poles, (p), is divisible by the number of parallel paths, (a/r), in each re-entrant section.* This condition of symmetry determines, for given values of p and a what shall be the re-entrancy of the winding. If, for instance, a 16 pole machine is to have four paths in parallel, the multiplicity of the series-parallel winding must, of course, be 2, and the re-entrancy may be either 1 or 2. A table of suitable values of r, the re-entrancy, for given values of a may readily be written down; for instance :—

p	16	16	16	16	16	16	16
a	4	6	8	10	12	14	16
m	2	3	4	5	6	7	8
r	1 or 2	3	1, 2 or 4	5	3 or 6	7	1, 2, 4 or 8

A further practical condition of symmetry, determining the choice of the number of slots in the armature core, will be discussed later.

The importance of symmetry in series parallel windings is great, but even symmetrical windings give unsatisfactory commutation unless they are provided with equalising connections. The need of such connections in the series parallel winding can best be explained by the discussion given lower down, of equalising connections in general.

Commutation with Multiplex Windings.—Multiplex windings possess the advantage of splitting up the process of commutation. In the case, for instance, of a four pole 400-ampere generator, the use of a simplex lap provides four paths in parallel and demands four brushes, whilst the current to be commutated at any one brush is 200 amperes. If the same machine were provided with a duplex wave winding equivalent to two simplex waves in parallel it would behave like two such simplex waves paralleled by having the commutator segments of the one interleaved with those of the other, the brushes being thick enough to touch both sets of segments at once. Since each segment would belong to only one of the two simplex sections it follows that as it left the brush the sparking would only be such as would be produced in a simplex wave-winding, delivering 100 amperes per brush. The second simplex section of this duplex winding would undergo commutation one segment later than the first. Thus, by the use of a duplex winding the process of commutation would be split up.

Multiplex lap windings are required only for machines of considerable current output, hence the thickness of brush required must be great, and the mere mechanical difficulty of ensuring definite and uniform contact over the whole of the brush face becomes considerable. The plexes of the winding are paralleled by the brushes, and should, even momentarily, inequality of contact occur over the thickness of a brush the distribution of current between the plexes would be upset with consequent overloading of individual plexes and sparking at the corresponding segments of the commutator.

[NOTE.—APRIL 7, 1918.—The author has just been informed that Mr. W. Cramp, D.Sc., was the originator of the method, used in the beginning of these notes, of deriving the lap-wound drum from the ring winding by stretching out the internal wires of the ring and laying them on the periphery. The author came across the method originally in Mr. Cramp's excellent little book on Armature Winding; but, finding it afterwards used by other authors, was not aware that Mr. Cramp was the originator of the method. The extension of this method, so that by its aid all symmetrical forms of drum windings, including the simplex and multiplex wave windings, may be derived directly from the ring winding, is, so far as the author is aware, original.]

(*To be continued.*)

Further Notes on American Methods of Handling and Storing Iron Ore and Coal.

In the "Materials Handling" Number of THE ELECTRICIAN* Mr. G. H. Hutchinson dealt with the methods of handling and storing ore and coal at the Lake ports. The map, which is given on p. 852, was unavoidably held over at the time, and in view of the urgent need of reform at home we take the opportunity of giving further particulars of the methods and machinery in use in America.

Reference to the files of the engineering [illegible] papers shows that development is proceeding at a rapid rate. Of the many recent articles that have been written on the subject those contributed by Mr. F. J. Warden-Stevens to our contemporary, the "Colliery Guardian," are of particular interest. [illegible]

[illegible]

* December 14, 191[illegible].

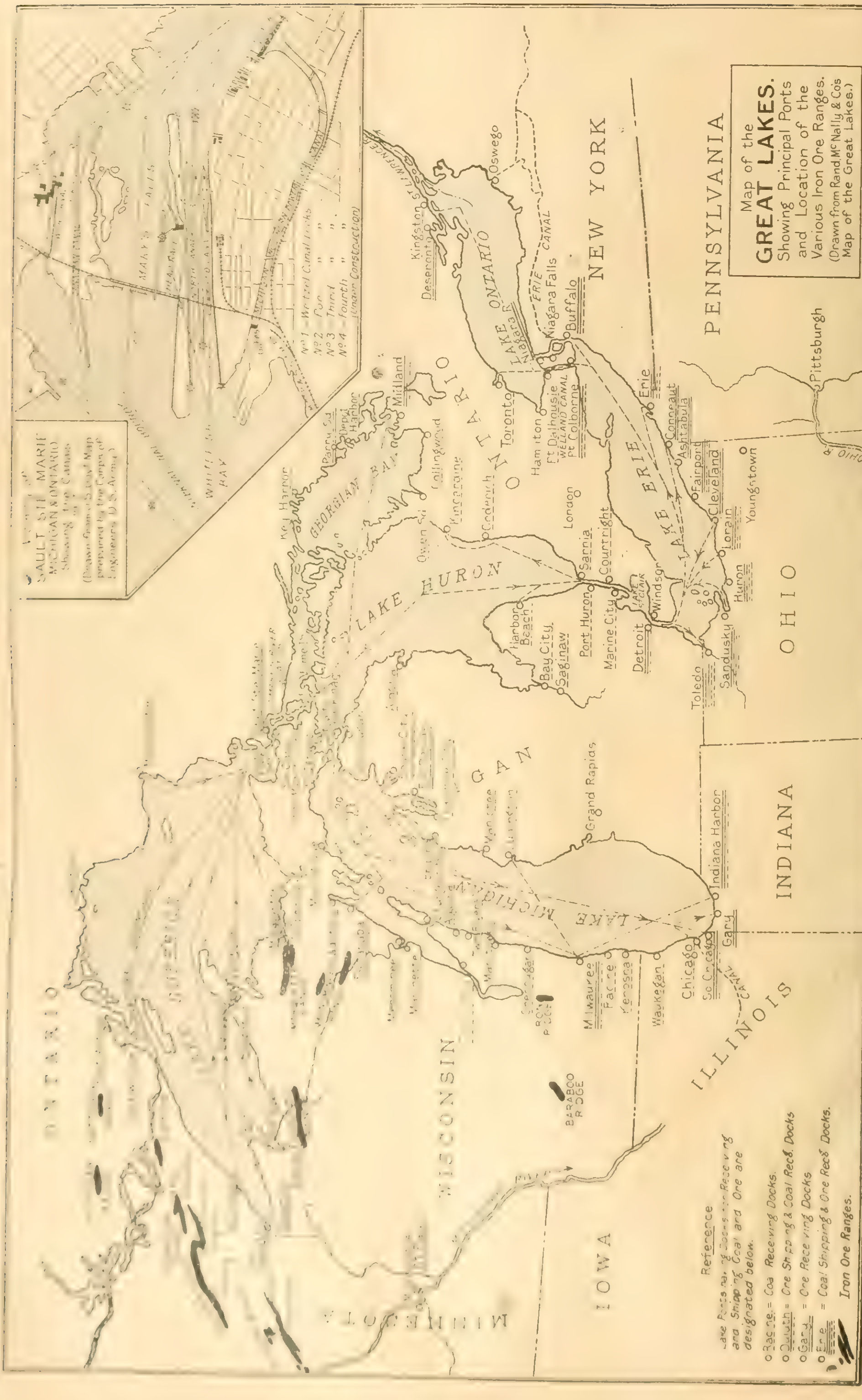


Fig. 1.—Map of the Great Lakes Showing the Location of the Iron-ore Ranges, the Principal Ports and Routes.

tion; but these are, for the most part, of small capacity. Seven of the docks are of semi-fireproof construction. The ore dock built, during 1916, for the St. Paul & Sault Ste. Marie Railway Co. at [illegible] nine trucks each, making a total capacity of nearly 60,000 tons of ore. The inclined bin floors, Fig. 3, span directly between the bin walls, which are 12 ft. from centre to centre. The 34-ft. steel

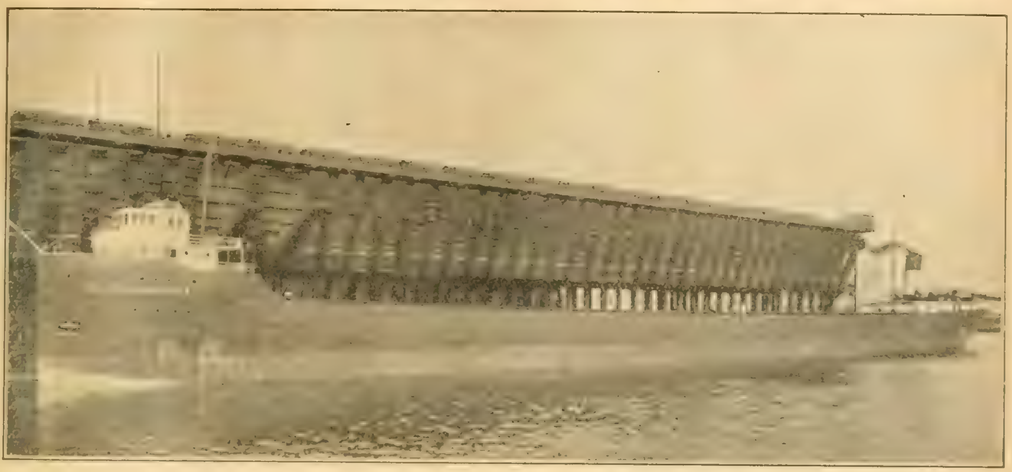


FIG. 2.—IRON ORE DOCK, HAVING A STORAGE CAPACITY 115,200 TONS.

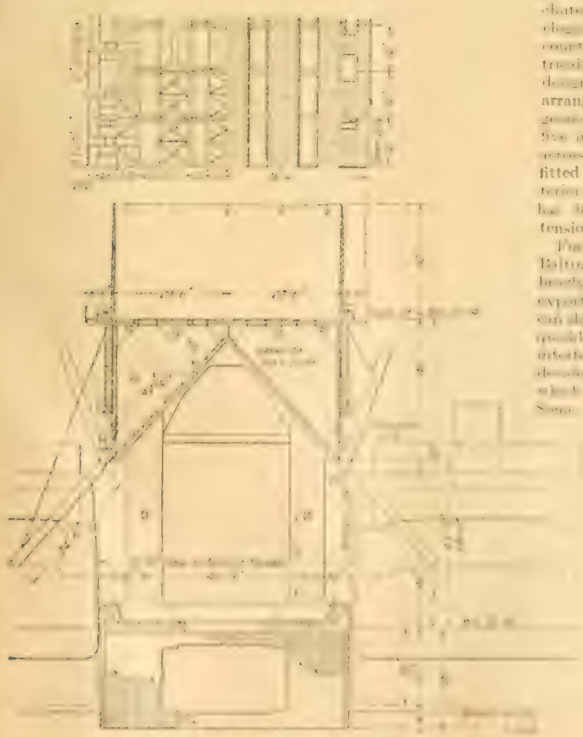


FIG. 3.—[illegible]

chutes are designed to carry the load resulting from the chutes [illegible] full of ore weighing 170 lb. per cubic foot. They are not counter-weighted, but are raised and lowered by means of electrically operated hoists located on the upper deck. These hoists are designed to raise or lower each chute in 32 seconds, and they are arranged in groups of 10 connected with a lineshaft which, in turn, is geared to a 25-h.p. motor. The upper deck is lighted by 15 rows of five incandescent lamps each, suspended from wire cables running across the deck between 30-ft. steel poles. Incandescent lamps fitted with suitable reflectors are provided for illuminating the interior of the bins, the door platforms and dock tender. Provision has been made at the outer end of the dock for a future extension.

Further reference may be made to the new coaling pier of the Baltimore & Ohio Railway Co. at Baltimore, Fig. 4, which was briefly described by Mr. [illegible]. This is said to be the largest export coal pier in the world and with its mechanical equipment it can ship 12 million tons annually.* [illegible]

[illegible]

[illegible]

the empty main belt doubles back and passes under the tower, on out to the end of the pier and back to the dumper.

The cross conveyor has three kinds of motion. The belt can be run in either direction to load ships on either side; the conveyor frame can be moved longitudinally, so that the belt will discharge 35 ft. beyond the side of the pier, and it can be raised and lowered within a range of 27 ft. to conform to the height of the vessel, the incline for the main belt being raised accordingly.

horizontal position, minimising the fall of the coal. The pan is then lowered to an angle of 50 deg. and a gate over the hopper automatically opens. At the same time the feeder belts start. When the pan is raised the gate automatically closes, and the feeder belts also slip automatically before the 15-ton hopper is empty. Thus, there is always a cushion to receive the coal from the lowering bin.

Coal can be taken from the hopper by any or all of the feeder belts at any time. The balancing bin is divided into eight units—four

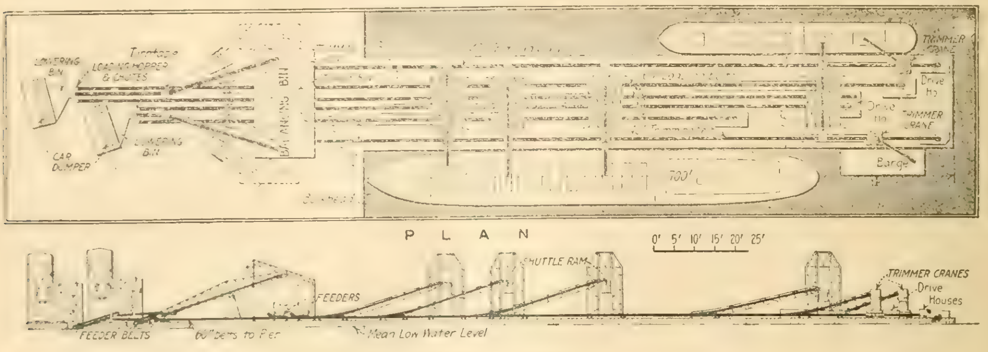
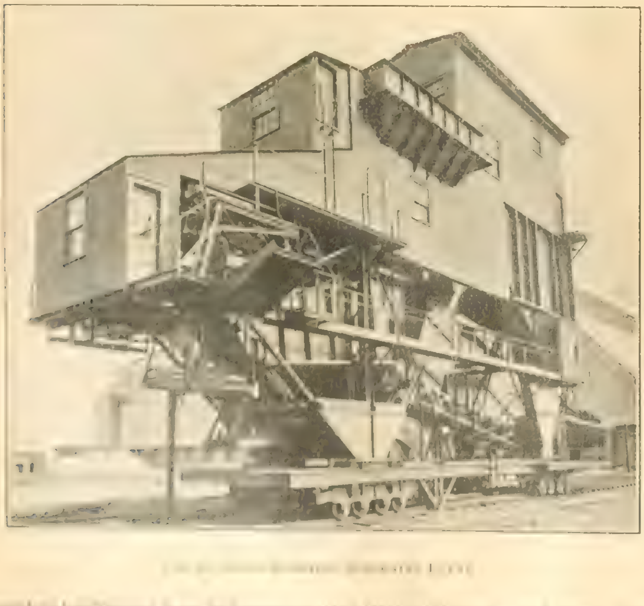


Fig. 4.—Cooling Pier at Baltimore.

In a similar manner each trimming belt serves a trimming tower, there being one such tower on a special track on each side of the pier. The belt passes up an incline on the tower and discharges into a hopper, which, in turn, feeds a conveyor on a swinging boom.

Normally the bulk of the coal delivered by the car dumpers is handled by the main loading belts. During the moving of the towers from one hatch to another, however, when these belts are



[illegible]

[illegible]

trimming hoppers with 750 tons capacity each, and four storage hoppers of 500 tons each. The latter, as shown in Fig. 4, feed the middle two of the four loading belts. The discharge gates of the balancing bin are controlled from the various towers.

The operation of the belts for any given unit is automatically interlocked to render the flooding of a belt impossible. When a unit—belt and tower—is put into operation the shuttle belt starts first, the main belt starts about three seconds later, and, finally, the feeder belt starts. Thus, each belt attains full speed before coal is delivered on to it. When the unit is stopped, the belts stop in reverse order.

All the belts have three speeds, namely 250 ft., 375 ft. and 500 ft. per minute. The purpose of this is to permit the proper handling of the various grades of coal to minimise breakage. The speed is absolutely controlled by the superintendent of the pier.

The entire plant is electrically operated. Subject to this speed control, and to emergency buttons every 20 ft. along the conveyors, by which the machinery can be stopped, but not started, the operation of each unit is controlled from a cab on the tower. This control includes the movement of belts, shuttle rams, trimming boom and the towers themselves.

As mentioned above, the total capacity of the pier is 7,000 tons per hour. With 12 men one unit will load a 7,000 ton vessel in 3 or $3\frac{1}{2}$ hours. This compares with $7\frac{1}{2}$ hours at the old pier, with 75 men. In other words, with the new equipment 7,000 tons of coal can be loaded with an expenditure of 36 to 45 man-hours, as against 563 man-hours with the old arrangements.

It should be mentioned that with the new equipment more than one unit can work on a ship, as each tower has the range of the whole 700-ft. pier, except at the ends, where widths of about 35 ft. for each unit limit the travel of each other. Adjacent to the pier are storage and shunting yards for the loaded and empty trucks, which are mainly of 50 tons capacity.

The practice of keeping storage coal under water in large basins is extending, and a very large storage basin of this kind has recently been constructed at an electric generating station at Pittsburgh. The basin is [illegible] ft. by 153 ft. at the bottom, $25\frac{1}{2}$ ft. deep, with side

slopes of 45 deg., and top dimensions of 740 ft. and 102 ft. Its capacity is 100,000 tons up to the top, or 150,000 tons with the coal heaped up above the water line to a total depth of 40 ft. Coal delivered from drop-bottom railway wagons is discharged into a hopper, from which it passes in a crusher, and is then carried by a conveyor to a 4,500-ton bunker over the boiler room, or fed to a 15-ton electric side tipping wagon, which discharges over the side of the storage basin. Coal brought by river barges is unloaded by a [illegible] ton grab bucket and delivered to other 15-ton wagons, which convey it to the crusher or to the storage [illegible]. The traversing is done by an electrically driven locomotive [illegible], which travels on a pair of standard gauge lines 20 ft. apart. The same crane recovers coal from the basin as desired and delivers it to the 15-ton wagons for transfer to the crusher or boiler room.

Fig. 5 gives a good general idea of the arrangement of the detached traversing screening plant in use at the Pittsburgh and Lehigh Coal Dock at Duluth, and for further particulars of one of these screening plants the reader is referred to The Electrician, July 23 and 30, 1915.

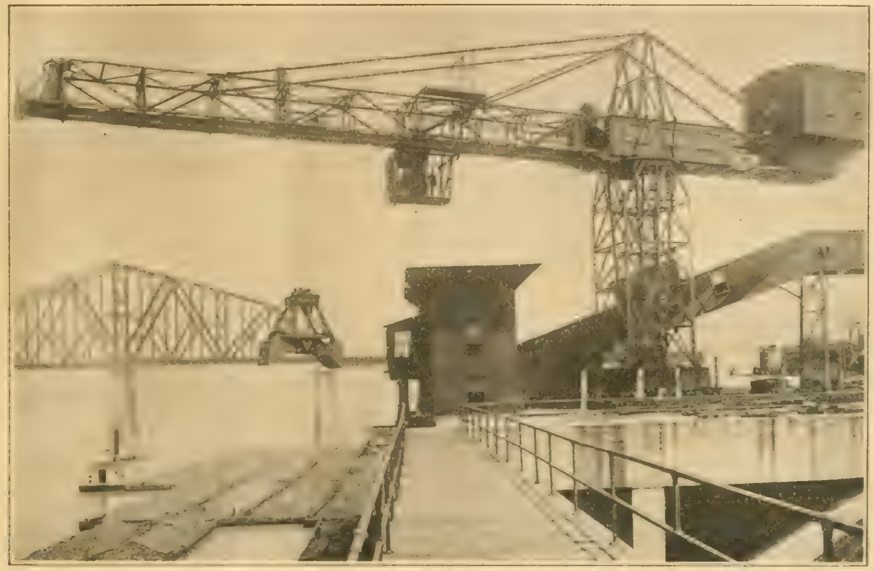


Fig. 6.—Travelling Crane with Revolving Jib for Unloading, Stocking and Reclaiming Coal.

Fig. 6 is interesting to those who are accustomed to seeing coal unloaded by [illegible] steam-driven locomotive cranes. The particular crane illustrated, which is installed at the La Belle Iron Works, [illegible], West Virginia, is of the travelling [illegible] type, and is equipped with a [illegible] grab bucket for unloading, stocking and reclaiming coal.

Magnetic Flux Distribution in Annular Steel Laminae.

A communication under the above title to the "Proceedings" of the American Institute of Electrical Engineers by Prof. A. E. Kennelly and Mr. P. L. Alger contains an interesting experimental study of the distribution of magnetic flux density in ring laminae. Among the chief conclusions arrived at the following may be noted:—

1. The flux density differs at different [illegible] of an annular steel lamina, under [illegible] magnetomotive force [illegible] flux density.

2. The distortion occurring both with continuous and alternating magnetomotive forces may be marked at low densities. At high frequencies, flux density distortion is complicated by skin effects.

3. With alternating magnetomotive forces a distortion is observed in the alternating [illegible] cycle flux density. [illegible] External [illegible] wave form.

4. The magnitude of flux density distortion may be defined as the difference between [illegible] flux densities, divided by the flux density at the [illegible] radius. In the test reported, the [illegible] was approximately [illegible] at low densities.

5. The magnitude of flux density distortion depends upon the [illegible] radius of the lamina [illegible] the less the distortion.

6. For a given width-radius ratio, the flux density distortion depends, to a first approximation, on the ratio of the [illegible] [illegible]

7. When the magnetic [illegible] [illegible]

8. [illegible]

The Electrician.

FRIDAY, APRIL 12th, 1918.

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The Importance of Chemical Science.

There is a good deal of truth in the view that whereas applied science in the form of engineering is not easily hidden, the effects of chemical science in industry are by no means so evident. A Forth Bridge, a "Mauritania," or a new aeroplane at once seize the public imagination, for they are complete in themselves and are perfectly tangible evidence of a continuous advance. But what does the man in the street know of sulphuric acid or of washing soda? The former he may know under the name of vitriol, of evil fame, and the latter he accepts as one of the cheapest of domestic commodities; but he does not realise that any remarkable chemical achievements have been concerned in their production.

We are led to make these remarks by the appearance of a small volume entitled "What Industry Owes to Chemical Science,"* by Messrs. R. B. PILCHER and F. BUTLER-JONES. In a short introduction, written by Sir GEORGE BEILBY, the aspect of the case to which we have alluded is pointed out, and the view is expressed that it is desirable to enlighten the general public as to the important part played by applied chemistry. We congratulate the authors upon the attempt they have made to remove this state of ignorance. The book includes 18 chapters dealing with [illegible] number of industries, among which we may mention minerals and metals, coal and coal gas, dyes, explosives and cellulose, rubber, glass, photography, brewing and alcohol. The book makes interesting reading, and is not written merely in popular style, so that it will appeal rather to the educated public than to the public at large. Every engineer should find it of interest, and many [illegible] benefit by a perusal of its pages, for we regret to say that frequently engineers do not realise the indebtedness of industry in general, and engineering in [illegible] to this branch of science.

From the point of view of the reader who has a general knowledge of chemistry it will be felt that there have been [illegible] developments in recent years of more than usual importance. One of these is described by the general term [illegible]. This term may be defined as a mode of facilitating the reaction between two bodies by the [illegible] of a small quantity of a third body, which apparently undergoes no change. The catalytic action of [illegible] is a classic example. The actions which take place are somewhat obscure, and the [illegible] at first [illegible] any great attention [illegible] catalytic reactions appeared to be uncertain in their character. This uncer- [illegible] phides; and the hydrogenation of oils, sometimes called [illegible]

* [illegible]

Another extremely well-known example is the synthetic production of ammonia by the Haber process, in which nitrogen and hydrogen are combined directly under the influence of a catalyst. This process now appears to be the backbone of the methods employed in Germany for the production of explosives.

The other remarkable development of a fundamental character is the application of electrical methods to chemical manufacture. Electrodeposition was in use, notably for the refining of copper, many years before a serious advance was made in other directions. The electrolytic production of aluminium followed, and then as electric energy became cheaper an advance was made into other spheres. As a result of laboratory work on the electric furnace, calcium carbide became a commercial product, and now the electric furnace is used in a variety of ways. Among the most important furnace products, ferro-alloys undoubtedly take a prominent position; thus we have ferro-silicon, ferro-chromium, ferro-molybdenum and others. These are not so dependent upon cheap energy owing to special qualities which are desired and for which it is worth while to pay. In the case of ordinary steel, however, the question of cost becomes more important. Nevertheless, electric steel is advancing rapidly, and in some countries even the electric smelting of iron ore is a commercial proposition. Among other electrochemical products of importance we may mention artificial graphite, alkali and bleach, phosphorus, carbon bi-sulphide and certain abrasives and refractories which have been found to be particularly useful. Mention should also be made of fused silica, which is now used for chemical apparatus, and whose production would be impossible but for the electric furnace.

Thus the electrical engineer may feel satisfied that he has contributed materially to the advance of applied chemistry; yet the work of the electrochemist is often somewhat overlooked, like that of the chemist pure and simple.

Review.

The Training of Our Industrial Forces. By H. F. L. ORCUTT. (London: "Engineering.") Pp. viii. + 55. 1s. 6d. net.

This little book is a reprint of three articles which appeared in "Engineering" in August and September, 1917. The author remarks that schoolmasters and Government officials can do little more than they are doing in regard to manufacturing development, unless supported and guided by our industrial leaders. Chief among the problems which industry has to solve is the attainment of the right outlook. "If history teaches us anything it teaches us that the pursuit of individual gain, to the exclusion of all other objects and principles, results sooner or later in revolution." The employer must therefore understand that labour-saving machinery should be applied to benefit both the worker and the owner; the continued introduction of such machinery involves higher wages and this will ultimately solve another problem—the matter of raising the school-leaving age—by removing the economic difficulty experienced by many parents.

Mr. Orcutt shows how general engineering shops tend to be displaced by highly specialised works, and how the training of employees must be adapted to this change. Management requires training and selection, even more than the rank and file. This is illustrated by the great achievements of scientific management, for example, in the work of Mr. F. W. Taylor and others. Finally he discusses, in succession, the training to be allotted to various classes of workmen, fitters, planers, pattern makers, &c., as well as the business staff.

The problem dealt with by Mr. Orcutt is an important one, and the book seems to us to be closer to realities in engineering education than is usually the case in discussions of this nature.

Obituary.

ROBERT WINTHROP BLACKWELL.

By the sudden death of Mr. Robert W. Blackwell, after a very short illness at his residence "Elmbank," Hampstead, on March 28th, the electrical profession loses one of the few remaining and best known pioneers of electric traction, and one whose name has been intimately connected with this most important branch of electrical engineering, both in the United States and in this country, for the last 35 years.

Born in 1858, Robert Blackwell graduated as M.A. and B.LL. at Princeton University where he was a contemporary of President Wilson, and afterwards practised as a Councillor of Law at the American Bar. Attracted, however, by the great demand for mechanically-operated street cars, the need for which was so urgently felt in the United States, he, jointly with Mr. Edward W. Bentley and Walter H. Knight, founded in 1883 the Bentley Knight Electric Railway Co., of New York, which installed and equipped an electrically-operated tramway system in Cleveland, Ohio, opened for traffic in 1884, and which was the first line to be operated electrically as a commercial undertaking.

Blackwell, as a contemporary of Sprague, Vanderpoel and Edison, was intimately associated with the great pioneer work carried out in the U.S.A. between 1883 and 1889. Speaking in Philadelphia at the sixth annual meeting of the Street Railway Association, on October 19, 1887, Blackwell stated: "We entered the electric city tramway field long in advance of all others; and we believe that electric street railways for city service can be used effectively only where the power to drive the car is transmitted to it from a generating station." How true this prevision was has been amply demonstrated, although at the time many thought the future lay with the storage battery.

THE LATE ROBERT W. BLACKWELL.

Blackwell was actively engaged with the management of his company until 1889, when he transferred the Bentley Knight Company's interests to the Thomson Houston Company, of Lynn, Mass. He was shortly afterwards summoned to England to give evidence before Parliament on behalf of the first Bill promoted by the Central London Railway Co., and it was the experience he gained during this stay which showed him the great prospects of electric traction in the United Kingdom and which eventually in 1890 induced him to take up his residence in this country. In 1890 he became associated with Messrs. Greenwood & Batley, of Leeds, in conjunction with whom he opened an office in London for the purpose of introducing electric traction on the tramway systems in the United Kingdom. Speaking about the United States before the Institution of Electrical Engineers in 1892, Blackwell said: "The public has thoroughly supported those tramways which have [illegible] electricity, and have rewarded their enterprise by greatly increased patronage. That electric traction will receive the same acceptance here that it has already gained across the water, I do not doubt." Time more than justified Blackwell's anticipations, although several years of arduous pioneering work were necessary to overcome the opposition of inertia and vested interests before electric traction was definitely established in this country. In 1894 Blackwell founded the firm of Robert W. Blackwell & Co., which ever since that time has been well known as one of the leading firms of merchants, manufacturers, engineers and contractors. All those who have dealt with this firm agree that it has deservedly acquired a reputation standing second to none for the uprightness of its dealings and the quality of its work.

In 1895 Messrs. Blackwell & Co. secured the contract from the British Thomson-Houston Co. for the construction and electrical equipment of a new tramway in Bristol, and the work they there carried out was so satisfactory that it at once secured them the premier position as contractors in the electric traction field. The very great financial success secured by this first electrification on a commercial scale, served as an incentive to many others to follow in the footsteps of the very enterprising Bristol Tramways & Carriage Co., and Bristol was visited and inspected by delegates from all parts of Great Britain and the Continent as the model electric tramway installation to be admired and copied.

As engineers and contractors Messrs. R. W. Blackwell were henceforth connected with a very large majority of all the electric traction systems installed in this country, and they supplied materials and engineering advice to a large number of Continental firms. They also carried out many important works for English railway companies, including the Great Western, the Great Central and the London, Brighton & South Coast Railway Companies. The work carried out for this latter company includes some of the most difficult bits of construction ever put up and erected under the most unfavourable conditions. The work was carried out to the design and under the supervision of Mr. Philip Dawson, M.Inst.C.E., &c., the consulting electrical engineer of the L.B. & S.C. Railway Co., who for the last 15 years of Blackwell's activities in this country had been intimately associated with him. This line has now been in operation for over nine years, and thanks to the observation of the principle always [illegible] as he said by Blackwell, of never doing bad work, the results have fully justified the confidence placed in him by the company, and have falsified the many criticisms made against the adoption of the overhead system by this company, as well as the predictions as regards the high cost of maintenance, frequent failures and [illegible] when the decision of the Brighton Company to adopt the overhead system first became known. At the annual meeting of the Brighton Railway on February [illegible] the chairman, Lord [illegible], expressed his satisfaction at the admirable manner in which Messrs. Blackwell had carried out their portion of the contract, and testified to the excellence of the overhead work and the perfection of the electrical work. At

founder and chairman of Robert W. Blackwell & Co. (Ltd.), Blackwell's name is a household word with all those interested in or connected with electric traction throughout the world.

Wherever anything new was to be seen or experience was to be gained there Blackwell went or sent his engineers or representatives to investigate and test, with the result that purchasers always came to him for information and advice. He exhibited in 1897, at the Brussels Exhibition, an exhibit which was one of the most interesting in the whole British section, and he was a member of the international jury there.

It is interesting to note that, although American born and a very prominent member of the American Society in London, all Blackwell's associates and staff were British, and the prescience shown by him in selecting men, and the kindly assistance and advice and loyal support he always gave his staff has resulted in the launching of a great many engineers into the prominent positions they now hold in many parts of the world. His motto has always been: "You cannot afford to do bad work; the best is only good enough."

Not only as an engineer and contractor, but in many other directions, Blackwell showed an initiative by building up a most successful roofing business, the material being made in his own works by the manufacture in this country of apparatus and materials which had previously had to be imported from abroad, and by doing everything he could to encourage British enterprise.

He was for many years chairman of Messrs. Johnson & Philips, the well-known electrical engineers and cable manufacturers, and did very much to bring them to the high pitch of prosperity they have reached to-day, and he was much loved and respected by his co-directors and the employees of this firm as he was by those of Messrs. Blackwell & Co. He was engaged in a pioneering industry and keenly felt the error so often committed of imposing too stringent conditions, regulations and penalties on any enterprise, which he justly contended was largely responsible for many industries in this country not making any sensible progress.

He had many outside interests which cannot be referred to here. Sufficient be it to say that he was in charge of most of the arrangements for looking after the American Military Mission during their visit to this country, and that he was a great supporter of the American Red Cross and kindred [illegible].

He was a member of the Royal Automobile Club and the City Liberal Club, and always retained his membership of the [illegible] Club of New York. He was a prominent Mason, and Past Master of the Lodge of the Nine Muses and the founder of the American Columbia Lodge, and [illegible] for his Masonic services.

His memory will be kept green in the hearts of all those who had the privilege of his friendship, and nothing was more characteristic of him than the opinion expressed by one of his oldest friends: "Blackwell was as straight as a die."

Correspondence.

ASYNCHRONOUS GENERATORS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir,—In the Editorial Notes on p. 834 [illegible]

[illegible]

hesitation in adopting even a smaller clearance, notwithstanding the fact that his problem is more difficult, for he has not only to consider the merely mechanical question of whipping, but also the effect of heat.

Your next point is the necessity of a laminated core. Such rotors are used in continuous-current turbo machines, and there is no reason why the same construction on a larger scale should not be used in an alternating-current machine. Prof. Field actually prefers a coarsely laminated rotor to a solid forging, so that this objection has not much weight. It is quite true that Prof. Field's laminations are 2 in. thick and rabbeted into one another; but even with good contact there will be some impediment to eddy currents. Moreover, the P.D. over the whole length of a tooth is less than half a volt, so that, even if there were no lamination at all, the loss by eddy currents would be inappreciable. In the example quoted by you on p. 834 the slip frequency is only 0·35 per second, and it is obvious that with so low a frequency the loss by eddy currents in the end bells must be quite insignificant.

You draw attention to the reliability of the phase advancer in the asynchronous as compared with that of the exciter in the synchronous machine. The juxtaposition of the two is perfectly legitimate; both machines are exciters and both are essential. There is, however, a considerable difference in the amount of mischief consequent on a failure of either. Although such a failure is extremely unlikely, it is interesting to inquire what are its chances in the two cases. The exciter must be driven by mechanical power, the advancer drives itself. I am here referring to the vibratory type of advancer. As the mechanical power may fail, we have here one point in favour of the advancer. Another possibility of failure may be the interruption of the exciting current of the exciter. This applies equally to the advancer, and in this respect the two systems are on an equal footing. But if the advancer is of the rotary type which requires no C.C. excitations we have a point in favour of the asynchronous principle. The exciting circuit of the synchronous motor may be broken. Here the asynchronous machine has the advantage, because there is no continuous-current exciting circuit. Finally, the connections between rotor and exciter or rotor and phase advancer may be broken. Here we have again parity; but as such an accident is practically impossible with the short, stout leads and massive connections, one need not further consider this case. We have thus three very remote possibilities of failure in the synchronous system against one equally remote possibility of failure in the asynchronous.

Now let us inquire as to the results of such a failure. If the exciting current of the phase advancer is cut off, the current in the stator will not increase, but may diminish to some extent. The power factor will, of course, alter very much for the worse. Instead of being of the order of 0·7 leading, it will become something like 0·9 lagging. If, on the other hand, the exciting current of either the exciter or the synchronous generator fails, its power factor becomes considerably worse, and the current may be doubled or trebled. I do not think these considerations of much practical importance, because an accident of the kind here discussed is extremely unlikely; but, as far as the argument has any weight, it shows the greater reliability of the asynchronous system.

What is of practical importance is the effect of accidents not inside, but outside the central station. Here the advantage of the asynchronous machine is clearly established. You do not criticise my statement that the switch and protective gear for the asynchronous plant may be simpler and less costly than for the synchronous, so I take it that you agree to that part of the proposition; yet this statement has been challenged in a private letter by an old friend of mine, who is a high authority on dynamo design. As others may share his views, I ask your permission for a few words of explanation. The argument I used in the discussion was that, as the asynchronous machine is excited from the 'bus bars, its internal voltage can never be higher than that of the 'bus bars. If, then, the 'bus-bar voltage is suddenly lowered as the effect of an abnormal load, no inordinate rush of current can be expected from the asynchronous machine, whilst the synchronous machine,

being excited from a separate source, will give an inordinately large current. Hence the necessity for reactance coils and extra heavy circuit-breakers. My friend points out that this reasoning is unsound, because the rush of current is not a function of any particular method of excitation, but is due to the energy stored in the magnetic circuit, whatever may be the method by which this energy has been stored. Even if it were physically possible to cut off the excitation at the moment of short-circuit, this store of energy must be dissipated, and hence there will be an abnormal rush of stator current. I do not accept this view, but as this letter is already so long that I fear you may refuse it if further extended by an analysis of this theory, I prefer to take the line of least resistance, and answer the objection on its own ground—that is, by reference to stored energy. It is well known that the air gap, and not the iron, is the principal seat of stored energy. The air-gap in the synchronous machine is 3 cm., that in the asynchronous 3 mm. The stored energy (and by hypothesis the mischief done by the rush of current) in the two cases should therefore be in the ratio of something under 10 to 1. —I am, &c.,

Birmingham, April 4. GISBERT KAPP.

THE IMPROVEMENT OF THE TURBO-ALTERNATOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your leading article in your current issue on the subject of turbo-alternator design must have caused surprise to many of your readers, in that you depart from your customary policy of detached and scientific criticism; and to some of your readers with a knowledge of metallurgy in that various inaccurate statements are made.

With regard to the first point, it is only to be expected that there will be differences of opinion with regard to this as with all subjects; but, in reviewing such matters, one reasonably expects a leading scientific journal to assume an impartial attitude and support statement with argument. The solid rotor is not an untried construction that is being advocated by a biased enthusiast, but is a construction that is in very general and successful use, and is the standard, and in some cases the only, construction of many leading British and foreign makers. This fact in itself would not to the scientific mind be an argument to rebut any specific criticism; but it is of primary importance in face of the summary statement that the solid rotor, except in small sizes, is inherently defective. You postulate that such is the case without any attempt at proof, since preceding the specific points to which you refer are the words that they constitute *additional drawbacks*. If your statement were true that the larger sizes of solid rotors are inherently defective, surely it would be a waste of words to discuss any *additional drawbacks*. There being no argument in support of your postulate one can only reply in the general terms I have indicated, and completely disprove your statement by pointing to the very general and completely successful use of the solid rotor.

I am of the opinion that the words have crept into your article by inadvertence, and that it was not your intention to announce to the world that the best of British machines of this kind have primary inherent defects. It is true that you do not specify the degree of the defect, but in the absence of any qualification the word implies degree as well as principle, and the only meaning to be read into your words is that large machines of this kind are incapable of successful running.

To deal with the metallurgical questions fully would require a good deal of space, so I shall have to content myself at the moment with a cursory reply.

The statement that a large mass of steel after heat treatment is liable to molecular change is most surprisingly inaccurate. Heat treatment in the form of very prolonged annealing and very slow cooling is the one and only possible means of giving complete stability to steel at ordinary temperatures—*i.e.*, the only means of preventing the slow molecular change to which you refer. No doubt when writing heat treatment you meant to write rapid cooling by quenching, and I will now deal with the matter on this assumption. Meta-stability is a function of rapid cooling, since it is a condition that results as a consequence of preserving in the steel the energy that would have been given out in the form of heat with slow cooling as the steel passed through its allotropic changes. It is obvious, therefore, that since the smaller the mass the more rapid is the cooling the smaller the mass, therefore, the greater is the degree of instability at ordinary temperatures. The reference to this interesting subject, however, is irrelevant to the controversy, since departure from a state of physico-chemical equilibrium is equally applicable to the steels used with the built-up designs, and indeed is applicable to all the metals of construction. The apprehensions of your readers, however, may be calmed, since the examination of ancient metal objects of 4,000 years old, and of steel some 2,000 years old, shows that the meta-stable state persists without observable diminution in degree over these periods of time.

The further statement that heat treatment does not penetrate to the centre of a large forging is equally incorrect, since the most thorough annealing can be carried out whatever may be the size of the forging. No doubt in saying heat treatment you meant to say oil hardening. To give emphasis to my remarks in dealing with this question I will take the specific case of a 50,000 kw. 1,500 revs. per min. single-forging rotor, which can fairly be described as being large. The diameter of such a rotor would be about 55 in., the depth of the slots, including the air ducts under the conductors, would be about 9 in. One would recommend that the slots be rough machined before heat treatment, and slots of equal depth would preferably also be cut in the polar horns, afterwards to be filled in to any desired extent by steel wedges. The cooling oil would thus have direct access to the most highly stressed parts of the core. Moreover, the presence of the slots would give the cooling oil such access to the body of the rotor that from this point of view it would be equivalent substantially to a rotor of not more than 40 in. in diameter. The steel manufacturer knows from experience and investigation that with such a rotor the cooling at the centre is sufficiently rapid to prevent any undue crystal growth. For such a rotor one would recommend a steel having an ultimate strength of about 40 tons to the square inch and a yield point of about 24 tons to the square inch. The maximum tooth stress would not exceed 6 tons to the square inch, and the maximum hoop stress would not exceed 5 tons to the square inch, both calculated at the overspeed of 20 per cent. above normal. It will be seen that such a rotor would have a decidedly higher factor of safety than is usual with small rotors, and would be satisfactory from every point of view.

It should be mentioned that the lightly assumed idea that the steel manufacturer is without knowledge of the condition of the steel in a large forging is quite wrong and quite unfair to the manufacturer. Most of our large steel manufacturers have excellently equipped metallurgical and chemical laboratories, and a great deal of investigation and research has been carried out. Ingots and forgings of all kinds have been cut open and analysed, tested and examined microscopically throughout. Perfection is unattainable with forgings as with everything else, but a forging made and guaranteed by one of our large steel manufacturers is as reliable as any material that can be employed and more reliable than most. With the improved solid plate construction there is substantially the same degree of impossibility of realising perfection in the materials used, and particularly with the long nickel-chrome steel bolts. In addition, there are all manner of indeterminate stresses in the bolts and the most undesirable dependence on the perfection of the many tapped holes. To state, as has been stated in this controversy, that the stress in the bolts can be reduced by the extension of them is wrong in the extreme. The determining factor is the maximum concentration of stress in the screw thread at the root of the nut, and that, so far, is beyond calculation at present. To appreciate how concentration of stress can be caused, let me consider the familiar example of a flat bar with a central hole pierced through it, the diameter of the hole being equal to half the breadth of the bar. The uninitiated would say that the presence of the hole, since it removes half the area of the metal, has the effect of doubling

the stress when the bar is carrying a given load. In point of fact, it has been shown mathematically and proved experimentally that the maximum stress is raised to over six times its original value. If there is this increase of stress with such a gradual change of section, what is the concentration of stress that is caused by the sudden change of section where a screw thread is cut and by the manner in which the load is transmitted from the nut to the bolt? Moreover, there is to be considered the enormous concentration of stress that the smallest error of pitch may cause. Mr. Stromeyer has just shown that with a screw thread of four to the inch, if the nut pitch is only 4/1000 in. finer than the bolt pitch, a local stress equal to the breaking strength of the material may be caused. Under a constant load the inherent defects of a screw thread are usually unimportant, for the reason that any local overstress is relieved by a plastic flow of the material. In the presence of alternating or intermittent stress, however, plastic flow is almost certainly the forerunner of fatigue failure, and for such a duty a nut and bolt must be regarded as a very unreliable piece of mechanism.

Fatigue failures may be extraordinarily slow and insidious, and the overwhelming objection to the construction under review is that the growth of such a fracture cannot be detected. That such a rotor has run for five years is no guarantee that it will not break down in another day.

In conclusion, there can be no doubt that a solid rotor that is backed by the guarantee of one of our large steel manufacturers will appeal to an engineer as being a much more desirable and safer construction than a rotor of many pieces bolted together, with which complete dependence has to be placed on a great number of machined fits and on the most unreliable of mechanisms for withstanding intermittent stress—a screw thread. The electrical manufacturer who cannot obtain high-grade forgings must be content with the next best construction; but this is expediency that is hardly relevant to a purely technical controversy.—I am. &c.,

Sheffield, April 8. S. F. BARCLAY, PH.D.

[We think that Dr. Barclay has to some extent misread our leading article, due, in part, to statements which are liable to be too general when made rather briefly. Our reference to "inherent defects" has been taken further than was our intention. It may, for example, be said that iron has an inherent defect as a material for rotor construction because it suffers from hysteresis loss; but this is not a *fatal* defect. We think our correspondent has assumed that by an inherent defect we mean a fatal defect. We agree that solid rotors have been used very successfully by British and foreign makers; but they may, nevertheless, present inherent defect which it is desirable to remove. Perhaps it would have been better to call these "inherent difficulties," as expressing the position more accurately; in fact, we call them "drawbacks" later, and these are not in addition to any inherent defect, but additional to a possible defect which our correspondent himself pointed out in his Paper. We certainly had no thought that our words would be taken to mean that large solid rotors are incapable of successful running.

Our correspondent is right in thinking that we had in mind oil hardening (to which he refers in his Paper under the heading "heat treatment"). We felt that the matter was open to question. Flow of heat presupposes a heat gradient. In very large masses of metal it is questionable (at least until proved to the contrary) whether the required rate of cooling for the exterior would give the required physical condition for the interior. We are glad to hear from our correspondent that there is no need for doubts upon this point.—ED. *E.*]

We regret that we find it necessary to hold over some correspondence.—ED. *E.*

B.T.-H. Current Limiting Reactances.

The desirability of limiting the current flow when a short circuit occurs [illegible] is coming to be generally recognised. With the increase in the size and number of generators connected to a [illegible] destructive power [illegible] at any switch which attempts limitation, and their value for this purpose is now generally acknowledged. Such a coil should possess the following characteristics:—

(1) Thorough reliability when suddenly called upon to limit the current; (2) great mechanical strength to withstand the heavy magnetic forces which are exerted on the conductors; (3) non-saturation of the magnetic circuit; (4) complete freedom from fire risk; and (5) ready accessibility for inspection. In adopting the under-mentioned form of construction, the aim of the British Thomson Houston Co., of Rugby.

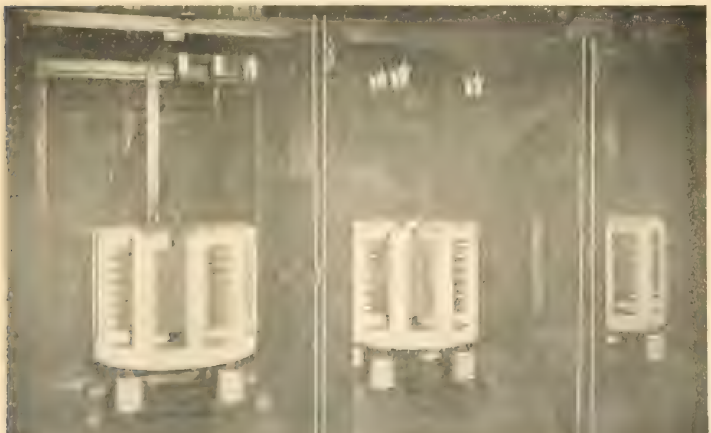


Fig. 1. [illegible] on Feeders.

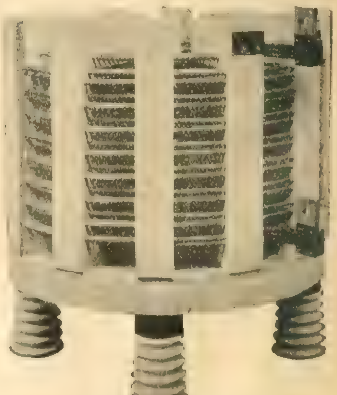
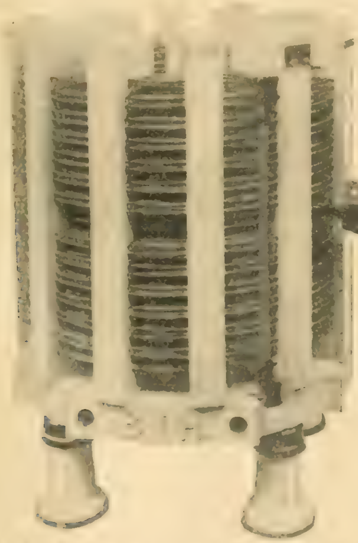


FIG. 2.—B.T.-H. CAST IN CONCRETE REACTANCE 79 K.V.A. FOR 5,500 VOLT CIRCUIT.

[illegible]

has been to produce a coil having these characteristics. The coil is in the form of a short solenoid with widely spaced turns, the whole being solidly held together by wedge-shaped blocks or pillars of specially cured concrete cast in radial positions around the conductors and bolted to a heavy concrete base ring. This construction ensures the two first conditions being fully realised. The heavy mechanical "blow" acting on the conductors when the first rush of current takes place tends to cause a radial expansion and also an axial compression of the whole coil. The radial force is readily resisted by the tensile strength of the copper, without tendency to distortion, and the axial force is taken by the compressive strength of the concrete. The lengths of unsupported conductor between pillars are kept well within safe limits.

The use of concrete, which is a highly insulating material, is rendered thoroughly safe by the thickness used between turns and layers. The layers are not in planes normal to the coil axis, but are wound slightly conically, so that the thickness of concrete increases with the voltage between conductors. This is readily seen in the illustrations, which give the coil the appearance of having layers wound in pairs. The whole coil is supported on stout porcelain insulators having ample leakage distance. For heavy currents several conductors in parallel are used, so wound that each conductor takes its full share of the current. In some cases, as in the 300 k.v.a. reactance shown, the coil consists of two superposed sections in parallel. One terminal is at the centre and the other formed by a vertical bar uniting the top and bottom ends. The third condition is met by the use of an air magnetic circuit, no iron being used. This ensures that the voltage absorbed by the coil is strictly proportional to the current. All risk of fire is removed by the use of entirely non-inflammable materials. The temperature rise of the copper [illegible]



[illegible]

[illegible] rules [illegible]

[illegible]

been found that with full-load current in the coil a modern shielded instrument may be brought quite close without its indications being affected more than 2 per cent. When three reactances are installed side by side the mutual attractive forces due to the currents tend to draw the coils towards one another. Where it is necessary, on account of space limitations, to place the coils close together, struts are provided between them to resist any tendency to movement. B.T.-H. current-limiting reactances can be supplied suitable for any circuit and of any kilovolt-ampere capacity.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Marks, Ellis & Pryor, Chartered Patent Agents, 70 and 72 Chancery-lane, London, W.C.

Whenever the date accorded for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1916 SPECIFICATIONS.

[illegible] (8 11, 15.) 102,140.

[illegible]

17,292 COOPER, T. L. R. Electric motors. (2/12 16.) 113,627.
A motor of the squirrel cage induction type is employed having its stator immersed in oil or other suitable insulating fluid, while the rotor is immersed in water which may either be in free communication with the external water in which the machine is immersed, or may be separately enclosed and supplied with water.

1917 SPECIFICATIONS.

[illegible] strips with upturned edges. (14 2/17.) 113,464.

2,398 ST. ARMANDE, A. V. Manufacture of multi-cell electric batteries. (17/2/17.) 113,469.

2,488 B.T.-H. Co. (G.E. Co.) Electric motor control systems. (20 2 17.) 113,473.

[illegible] sets for emergency or stand-by purposes for ships, public buildings, and for other purposes. (21.2.17.) 113,479.

2,991 RIGGS, A. L. Spark plugs. (28 2 17.) 113,495.

2,994 WYBAILLIE, F. M. A., & PEYMAN, A. Electric incandescent lamps. (28 2 17.) 113,496.

3,039 COHEN, L. Wireless radio signalling by the arc system. (1 3 17.) 113,498.
[illegible] and means for producing radically different electrical time constants in the said two circuits, and to so proportion the said time constants in relation to each other that when both circuits are closed a considerable oscillatory current will exist in one circuit and substantially none in the other circuit.

[illegible] (2 3 17.) 113,502.

3,258 OLDHAM, O. Miners' and like electric safety lamps. (5 3 17.) 113,506.

3,285 GRIFFITH, C. O. Electro-chemical process for the treatment of metallic ores (6 3 17.) 113,508.

3,295 B.T.-H. Co. (G.E. Co.) Systems of control for electric motors. (6 3 17.) 113,509.

[illegible] 108,849.

[illegible] not granted.) 113,519.

[illegible]

Volunteer Notices.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

[illegible]

Saturday, April 20.—Commandant's Parade for Drill in Hyde Park, 2.45.

[illegible]

Recruits will attend for Instruction [illegible] with the Companies.

Commercial Topics.

Priority Certificates for Electric Motors, &c.

It is announced that in future all applications to the Ministry of Munitions for priority certificates to enable motors and other electrical plant (requiring a supply of current from the public mains) to be purchased should be accompanied by a certificate from the Chief Engineer or Manager of the public service undertaking concerned, stating :—

(1) That adequate generating plant capacity is or is not available; (2) that no additional cost or material is involved in connecting the premises to the mains (including substation equipment, if any), or (3) where expense is involved, the material and apparatus to be provided and the cost thereof, and whether lead covered cable is necessary or not. Where lead covered cable is deemed necessary, the voltage of the current transmitted should be stated.

Applicants should, whenever possible, also obtain the written support of the Government Department interested in their manufactures, and forward a copy of same. The purpose of the above procedure is to reduce the demand for current—other than that used for urgent war purposes—supplied by the public service undertakings, and the time occupied in making enquiries.

* * * *

Engineering Trades (New Industries) Committee.

We understand that the principal function of this Committee, which was recently formed by the Ministry of Reconstruction, is to assist the engineering trades in dealing with the problems which will inevitably arise in the establishing of new industries in order to provide employment for the large amounts of new labour and plant which have come into being during the war.

It is, therefore, important to the various branches of engineering as well as of individual manufacturers that the Committee should be informed of all new projects for expansion of businesses after the war, with the object both of securing as far as possible supplies of materials and of preventing such disappointment and failure as might result if a number of concerns who were ignorant of similar developments contemplated elsewhere devoted their energies to the same articles, thus creating a production possibly greatly in excess of actual requirements.

The gentlemen who are giving their time to the work of the Committee are themselves manufacturers of wide experience, and are desirous of assisting those who desire to extend existing or to engage in new branches of manufacture. It would, therefore, be most desirable to know the difficulties which they anticipate in extending after-war industries, in order that, so far as practicable, they may secure the assistance of the Government in overcoming such difficulties. In view of the inevitable shortage of materials for engineering work during the period following the war it is almost certain that some materials will continue to be controlled by the Government, and a priority for materials for new or extended industries of a character approved by the Committee may not improbably be granted to some extent on their recommendations. In this connection we understand that the Committee consider that [illegible] in manufacture should be encouraged, and that with a view to finding the greatest possible opportunities for the employment of labour those industries in which labour forms a relatively large part of the cost of production will probably be specially favoured. Manufacturers [illegible] been encouraged to rely upon their own efforts and upon good organisation and management rather than upon protective tariffs, which involves a political issue not within the purview of the Committee. The offices of the Committee are at Armament Buildings, Whitehall-place, London, S.W. 1, to which address communications may be sent.

* * * *

Reconstruction Problems.

At [illegible] last week the Minister of Reconstruction (Dr. Addison) gave an address on "Some After-War Problems of Industry."

[illegible] by the Industrial Reconstruction Council [illegible] Mr. [illegible] outlined [illegible] that industrial prosperity [illegible] for the future was [illegible] employed.

[illegible]

cessation of hostilities they must face scarcity in certain essential and important materials, and they invited the different trades to set up an organisation whereby if rationing was required they would do it themselves.

One of their greatest difficulties was the lack of representative trade organisations. They wanted trade Committees whereby, apart from the transitional period, understandings might be arrived at as soon as possible to enable both employers and employees to co-operate in restoring and increasing productive activity after the war. Artificial limitation of output should be done away with, and that could only be done on a secure basis if the workman had an arrangement whereby he was satisfied that if he participated in increased production he got a fair share of the reward, and he must not be in peril of unemployment by increased production. Regarding the supply of raw materials, it would be inevitable for some time after the war that there must be some power of regulating the order of imports. We should be short of certain vital materials. If we did not have raw cotton Lancashire would be out of work. Speaking of the need for exploring new channels of industry, he pointed out that in connection with demobilisation of civil workers, one of the most important things would be to find openings for the employment of women war workers. There were great possibilities in that direction. Those things must be done in an organised way, and once they started with the formation of industrial Committees or groups to deal with specific questions affecting the interest of the industry as a whole he had no fear of the future. He urged the importance of the application of science to industry with which the Government were helping by grants to trade organisations which would undertake research.

* * * *

Association of Chambers of Commerce.

The forty-eighth annual meeting of the Association of Chambers of Commerce of the United Kingdom took place on Tuesday and Wednesday, under the presidency of Sir Alex. Firth. The annual report and balance-sheet were approved, and Mr. E. Manville was elected president for the ensuing year.

In his presidential address Sir. Alex. Firth reviewed the Government man power proposals, and dealt with the Board of Trade reorganisation, the relations between Capital and Labour, taxation, &c. He hoped that the changes made in the Board of Trade would be justified, and that the Board would become a real Ministry of Commerce. Paying tribute to the work of Sir Albert Stanley, the chairman said that the experiment of putting a business man at the head of a business department rather than a politician had proved an unqualified success. He appealed for support for the trade bank—the British Trade Corporation. The world upheaval had shown the nations their inter-dependence. Referring to the coming Budget, he thought it would be a great mistake if any addition was made to the amounts levied under income-tax, super-tax or excess profits duty, our industries being quite sufficiently taxed at present.

Among openings for our industries after the war, Sir Algernon said there would be demands for immense quantities of new machinery, railways to re-equip, ships to be constructed, houses to be built and others to repair, schemes for the supply of electric power and light, inland waterways and canals, supplies of all manner of goods urgently needed. There would be no lack of employment if only the right means were adopted for providing for all those demands. They could not fail to notice the spirit of animosity to the employers which was apparently fostered by a certain class of political profiteers and by superficial economists without practical experience. On the other hand, two hopeful developments were the Whitley Report and the National Alliance of Employers and Employed. Our industries had to be organised if we were to face future competition. Want of organisation had been a great difficulty which the Board of Trade, the Ministry of Labour and the Ministry of Reconstruction had found on attempting to assist the formation of industrial councils. If industrial councils were to be a success, trade unions should concentrate their activities and endeavour to embrace all classes of labour employed in an industry in the same organisation.

Decimal Coinage.—A resolution was passed urging the Government to pass the Bill for decimalising the coinage.

* * * *

Development of Home Oil Resources.

A committee of six members (with Lord Crewe as chairman and Mr. G. C. Smallwood, of the Ministry of Munitions, as secretary) has been appointed by the Minister of Munitions—

To consider the report of the Petroleum Research Department on the production of fuel oil from home sources, and to advise to what extent, and within what time, it should be possible under present conditions to carry out the proposals made in this report; and to consider the steps taken by the Ministry of Munitions in this connection.

* * * *

Control of Electric Converter Plant.

The Minister of Munitions has ordered that, as from the 5th inst.,

No person shall until further notice purchase or manufacture, or erect or install in or in connection with any factory, workshop, steel works, shipyard, colliery or other premises for the purposes of which alternating current is or can be made available, any rotary converter plant, motor generator plant or converter plant of any description for transforming alternating current to direct current, or any part of such plant, except under and in accordance with the terms of a licence issued on behalf of the Minister of Munitions by the Director of Electric Power Supply.

Any necessary repair to converter plant already installed may be effected, and the purchase, manufacture, erection or installation of converter plant required solely for electro-chemical or electrolytic processes or electric traction is also not affected.

Applications in connection with the Order should be made to the Director of Electric Power Supply, Ministry of Munitions, 8, Northumberland-avenue, W.C. 2. The licence required by the present Order is in addition to and not in lieu of the usual Priority Certificates and permit reference number. Applicants for licences are warned against purchasing or installing d.c. motors before the licence for the necessary converter plant has been obtained.

* * * *

Electricity Supply in Japan.

According to a statement issued by the Department of Communications of Japan at the end of July, 1917, there were 568 companies (with a capital of £32,159,000) supplying electrical energy; 42 electric railway companies, with £4,341,400 capital; and joint electric supply and railway companies, with £29,696,000 capital. Compared with the figures for the corresponding period of 1916, there is an increase in the number of enterprises of 35, with an aggregate capital of £3,578,412.

Electricity Supply.

Extensions.

Belfast.—A Local Government Board inquiry was held on Thursday and Friday last into the application of the Corporation to borrow £310,750 for the erection of a new generating station on the Harbour estate and for the purchase of generating plant, &c.

Mr. JAMES ANDREWS, K.C., appeared in support of the application, and gave particulars of the development of the electric supply department and the history of the negotiations for the purchase of the new site. The demand for electrical energy for power was increasing, and at first it was thought it would be only necessary to put in some machinery at East Bridge-street station. The plant was ordered, but, owing to the war, it had not been delivered. On account of communications received from Messrs. Workman, Clarke & Co. and Messrs. Harland & Wolff the Corporation became convinced that a larger scheme was necessary.

After evidence had been given by the town clerk (Mr. R. MEYER) and the city accountant (Mr. R. GEALE), the consulting engineer (Sir JOHN SNELL), supplied technical details of the scheme. He was taken through the items of expenditure making up the total of £310,750 by the inspector, and said that temporary structures would be possible if all the materials for building were not obtainable. There were at present two completely different sets of plant at East Bridge-street—one for the tramways and one for lighting purposes. By the new proposal that would be done away with, and one set of generators would be able to supply energy for all purposes. They would get a better load factor, and in addition part of the current would be sent to the Chapel-lane station for street lighting. By erecting the station on the Harbour estate they were anticipating the growth of their load, but they must make up their minds to take up the question of power supply now or for a number of years have nothing to do with it. Owing to the great demand for shipbuilding, there would be difficulty in getting boilers, and he had been informed by the Priority Department of the Ministry of Munitions that if it could be avoided they would prefer that the Harbour site should not be proceeded with. There was one important provision, however. If the shipbuilding yards had within sight as between now and 1920 such extensions as would demand their coming to the Corporation or going to the Ministry of Munitions for independent plant the Ministry would prefer that the Corporation should put the plant in their station instead of the shipyards putting in independent plant. Expert opinion was against the combination of gas works and electricity undertakings. He said most emphatically that there was no comparison between the benefit of getting coke for firing purposes and the getting of an unlimited supply of condensing water—all was in favour of the latter. Messrs. Harland & Wolff would purchase current on quite a large scale from the Corporation as soon as it could be given. They would also agree to give up a generator which was partly constructed for their own installation. It was almost impossible to gauge accurately what development was going to take place, but that it would be very great those in the shipyards were convinced. He felt that having regard to the unknown development in shipbuilding which was in the future Messrs. Harland & Wolff, even if they established their own new site, could not keep up to their demand, and would be either obliged to do something more for themselves or come to the Corporation. The other important shipyard (Messrs. Workman & Clark) required a substantial amount of power which the Corporation had undertaken to give them, and they required power for another of their yards. Messrs. Workman & Clark would require 750 kw. before the end of the year and 1,000 kw. before the autumn of next year. In the south yard they would take 400 kw., and after that as much as the Corporation were prepared to give up to 1,000 kw. Messrs. Harland & Wolff were prepared to take 400 kw. up to August, rising to 1,000 kw. up to Dec. 31, and in addition to take 1,000 kw. of direct current up to Dec. 31, rising to 2,000 kw. up to the autumn of next year.

Councillor Duff said there was a demand by the shipyards for 14,000,000 units.

The City Electrical Engineer (Mr. J. W. [illegible]) said he was in entire agreement with the present scheme, which was absolutely necessary if they were to comply with the requirements of the shipbuilding yards. He considered the proposed site ideal, as it would be capable of development. The advice he had given to the Corporation on general lines during the past seven years had been borne out by the reports of experts to the City Council. After paying all charges, they had an approximate profit of £6,000 on last year's working. In 1916 they had a request from the York-street Flax Spinning Co. for 40 H.P., but they were unable to comply with it, and many other applications had been refused.

Evidence was also given by the city surveyor (Mr. H. A. Cutler), by Councillor Duff, vice-chairman of the Electricity Committee, and by Ald. Coates, chairman of the Finance Committee.

Leith.—A report of the electrical engineer (Mr. A. P. Rutherford), recommending an expenditure of £60,000 on additional generating plant, &c., has been referred to the Committee dealing with the development of local industries.

Newcastle-under-Lyme.—The Council has received sanction to a loan of £3,000 for the linking up of the electric supply undertaking to that of Stoke-on-Trent.

Salford.—The Corporation has applied to the L.G. Board for permission to borrow £15,000 for the extension of a sub-station, cable laying, &c.

The scheme will complete the linking up with Manchester, and be of assistance when the greater scheme of utilising electrical supplies comes into operation.

General.

Blackburn.—Councillor Chas. Higham, vice-chairman of the Electricity Committee, and Mr. P. P. Wheelwright, borough electrical engineer, will represent the Corporation at the annual conference of the I.M.E.A., to be held at Manchester in June.

Cork.—The Corporation have appointed a Committee to consider their position under the Cork Electric Lighting Co.'s Provisional Order, and to report on the present condition of the plant and mains of the Company.

Derby.—The Council has decided to purchase premises for offices, workshops and showrooms, at £3,765.

Eastbourne.—The Council has granted an honorarium of £50 to the borough electrical engineer (Mr. J. K. Brydges) for extra work performed in consequence of the illness of Mr. Blake.

Huddersfield.—The Corporation has increased the salary of the electrical engineer (Mr. J. W. Turner) from £400 to £500 per annum.

Increased Charges for Electrical Energy.—The charges for current at the following places are being increased:—

At Stoke-on-Trent the Electricity Committee recommend an increase of 20 per cent., making 60 per cent. over pre-war charges, commencing from the April meter readings.

Rotherham Electric Light Committee propose an increase of 13½ per cent. in the charges to industrial power users.

Ballyconnell Electric Light Co. have decided to increase their charges by 1½d. per unit to shareholders and 1½d. to non-shareholders.

Carlisle Electricity Committee have decided to increase their charges by 5 per cent. (making a total increase of 25 per cent. over pre-war charges) to all consumers other than those having agreements.

Hampstead (London) Council are increasing their charges from 33⅓ to 50 per cent. over pre-war charges.

Worksop Council is increasing its charges by ½d. per unit for light and ¼d. for power.

At Torquay the rate for lighting is being increased 1d. per unit, and that for power and other purposes ½d. per unit.

Birkenhead Electricity Committee recommend further increases of 12½ per cent. for lighting, ½d. per unit through prepayment meters, and 10 per cent. for power.

At Maidstone the charge to ordinary consumers was recently increased [illegible] per cent., and that to consumers with contracts 2[illegible] per cent., in addition to increases under the coal clause based on price of coal.

Bexley Electricity Committee recommend a further increase of [illegible] per cent. in the charges for current.

Luton.—The salaries of the chief assistant engineer (Mr. H. Kell[illegible]), the chief technical assistant (Mr. A. H. Coates) and the chief clerk of the electricity department (Mr. R. [illegible]) have been increased by £25 a year each.

Newcastle-on-Tyne.—The Parliamentary Committee has expressed the opinion that in view of the large profits earned by the Newcastle-upon-Tyne Electric Supply Co., and the payment of 8 per cent. dividend, the proposed increased charges of 20 per cent. for lighting and 15 per cent. for heating are not justified.

The committee further recommend that application be made to the Board of Trade for a reduction in the charges. With regard to the Newcastle & District Electric Lighting Co., which is making a similar increase in charges, it is recommended that a Board of Trade investigation be asked for.

Pontypool.—The Urban Council has decided to proceed with the scheme for the purchase of the undertaking of the Pontypool Electric Light & Power Co. as soon as the L.G. Board give their sanction.

Portsmouth.—The salary of the electrical superintendent (Mr. W. S. Fowler) has been increased from £550 to £600 per annum.

Sandgate.—The Urban Council has decided to adopt electric pumping at the pumping station.

Scottish Municipal Electrical Undertakings.—At the annual convention of the Scottish Royal Burghs last week, ex-Bailie Alex. Stevenson (Edinburgh) moved approval generally of the recommendations in the recent report made by the Coal Conservation Sub-committee on the subject of electric power supply, with the reservation that the control of generation and supply should not be entrusted to power companies, it being in the public interest that the control should be vested in public or municipal authorities.

Mr. STEVENSON said he saw in the report a real menace to the rights and privileges of municipalities. No municipality could afford to ignore the possibilities of an up-to-date electrical undertaking, because the general use of electricity would give a purer atmosphere to our cities and towns and make healthier homes. According to the report, the power company lion and municipal lamb were to lie down together, but in the present case the municipal lamb was inside the power lion.

[illegible] Kilmarnock seconded, and said that was simply an effort to roll the transactions of municipalities into the hands of large power companies for the exploitation of electrical undertakings in Scotland.

The resolution was passed, and the matter was remitted to the annual committee to consider what action might be taken to safeguard the interests of municipalities.

Wednesbury.—On Monday the Corporation decided, on the recommendation of the General Purposes Committee, to dispose of the municipal electricity works to the Midland Electric Corpn. for Power Distribution and to apply for a provisional order to enable this to be done.

The Company will pay to the Corporation the capital expended on the undertaking by 15 annual instalments of £5,000.

The Committee's report pointed out that with a population of 30,000 there were within the borough four statutory authorities with powers to supply electricity and gas for power purposes, while the increased prices of materials of all kinds, the increased rates of wages, and the interim report of the Reconstruction Sub-committee, indicating the creation of larger areas for the generation and supply of electricity seemed good and definite reasons for the disposal of the undertaking.

The Mayor (Ald. A. E. Pritchard) said they had no tramways or any public works requiring electric current, while their machinery for producing electricity was somewhat obsolete, and therefore costly. They had been compelled to buy in bulk to meet the requirements, and the whole result had been an annual loss for the past few years. They aimed at safeguarding consumers in regard to power supply and he thought the agreement would protect all interests.

Wrexham.—The Electricity Committee recommended the Council to increase the salary of the electrical engineer from £375 to £425, but as there is a Council minute fixing the maximum salary at £400, the matter has been deferred until this is altered.

Electric Traction.

Birmingham.—The Corporation decided on Tuesday to ask the [illegible] of the tramway fares.

[illegible]

Bradford.—[illegible]

[illegible]

Lancashire Tramways.—The Board of Trade has extended by one year from Feb. 6, 1918, the time during which Ashton-under-Lyne Corporation, Audenshaw and Denton Urban District Councils and Waterloo and Bardsley Parish Councils are entitled to give notice of intention to exercise their option of purchasing the portions in their respective districts of the undertaking authorised by the Oldham, Ashton-under-Lyne, Hyde and District Tramways Order, 1896.

Liverpool.—Mr. J. S. D. Moffet, the tramways manager at Belfast, who was recently recommended for the position of deputy general manager of the Liverpool tramways, has decided not to accept the position, as Belfast Corporation has increased his salary to a maximum of £1,200 per annum, to be reached by annual increments of £100 till September, 1921.

Metropolitan Railway.—The Board of Trade has extended by one year the times limited for the completion of the railway described in Sec. 16 of the Metropolitan Railway Act, 1913, for the compulsory purchase of lands for lines described in Sec. 5 of the Metropolitan Railway Act, 1912, for the completion of Works authorised by Sec. 5 of the Metropolitan Railway Act, 1911, and for the purchase of lands authorised by the Metropolitan Railway Act, 1913.

Women Tramcar Drivers.—Hitherto women tramcar drivers have not been licenced for the London area, but Mr. Jas. Devonshire, chairman of the Board of Trade Tramway Control Committee, states that it is probable that women will be licenced as tramcar drivers shortly in the metropolitan area.

York.—The Tramways and Electricity Committee recommend an increase in the salary of the tramways manager and electrical engineer (Mr. J. W. Hame) from £550 to £650 per annum, rising to £800 by annual increments of £50.

The wages of men in the Committee's employ have been increased to 20s. per week over pre-war rates and women by 4s.

Telegraphy and Telephony

P.O. Telegraphs and Telephone.—The accounts of the Post Office for the year ended March 31, 1917, show a deficiency of revenue amounting to £529,639, an increase of £9,592 on that of 1915-16.

The deficiency arose after making provision for pension liability, £402,440 (only £195,753 was expended); depreciation, £287,618 (£129,955 only was expended on renewals, &c.); and for an expenditure of £129,757, in respect of Post Office employees serving with the Colours, &c.

The telephones show a surplus of £201,729, compared with a deficiency of £118,177 in 1915-16.

The actuarial percentages used in arriving at the pension liability involved an increased charge of £18,234 for the year under telegraphs, and a decrease of £29,703 under telephones, mainly owing, in the latter case, to the lower percentage (11, as compared with the provisional rate of 15) applied to the engineers.

Foreign Notes.

Bagdad.—The main street of Bagdad is now lighted electrically.

Ecuador.—The Guayaquil Electric Light & Power Co. has recently expended $50,000 on new plant and mains, and it proposes to spend $200,000 further. The orders will, it is said, be placed in the United States.

Japan.—The "Financier" states that an electrical exhibition will be held at Tokio shortly.

Since the commencement of the war at least 20 new companies have been formed in Japan, with a capital combined of 30,050,000 yen (about $3,100,000) to carry out developments of chemical industries, and there are frequent announcements of new hydro-electric enterprises.

Malay Mineral Wealth.—The U.S.A. Vice-Consul at Bangkok reports that mining engineers who have recently visited the Southern Siamese Malay States have come to the conclusion that one of the richest mineral areas in the world is to be found there.

In addition to wolfram, rich deposits of tin alluvium are found in the valleys and gullies of all the hills in which wolfram has been located. Over ten wolfram lodes have already been located, and in all of them tin has also been found. Plenty of water with sufficient head is said to be available for working out the tin in the rainy season, and there is a waterfall close by with sufficient head to develop electric power for working a large number of mines. In Northern Siam mining areas crossing the new railway extension have been opened, and here antimony and lead worked for, lead being associated with zinc and silver.

Rome.—Further restrictions have been imposed on the use of electricity both for lighting and heating.

Spain.—An official announcement contains a list of materials which may be required by Spanish Government Departments during the present year, and in which foreign competition will be permitted.

These goods include bitumen, oils and greases, manufactured steel, zinc, tin, nickel, aluminium, platinum, bronze and copper goods, steam turbines, gas engines, boilers, machine tools, electrical laboratory apparatus, electrical measuring instruments, telegraph and telephone appliances, electric searchlights, submarine cables, arc lamps, electric lighting accessories, electric generating machinery and scientific instruments.

Water Power in Hungary.—The "Board of Trade Journal" announces that the constantly increasing price of coal has caused the electrical undertakings in Budapest (the Municipal Electricity Works, the City Railway, and the Tramways), which require several hundreds of truckloads of coal per day, to form a syndicate (the Hydro-Electrical Co.) for investigating and organising the use of Hungarian water-power for the generation of electricity.

Miscellaneous.

Bose Research Institute.—Leading citizens of Bombay recently presented a purse of Rs. 2,00,000 to Sir J. C. Bose as a recognition of the great service rendered by him to the cause of science. Sir Jagdish Bose, in accepting the purse, said the amount would be held in trust by a committee of three for the use of the Bose Institute.

Concert.—The London and Southern Division of the Electrical Power Engineers' Association gave a very successful smoking concert at Anderton's Hotel (Fleet-street, London) on Monday evening last.

The chairman (Mr. A. C. Bostel) presided over an audience of more than 100 and owing to the large number of tickets sold the Electrical Trades' Benevolent Fund will receive a substantial sum. The programme was a good one and much musical and histrionic talent was displayed by members of the Association. The older members were given an opportunity of meeting the latest recruits, engineers on the staffs of electrical manufacturers and men in charge of power plants in London factories.

During the interval Mr. Ebben, the late general secretary of the A.E.S.E. (which formed the nucleus of the present Association), was presented with a gold watch and a cheque, gifts which were subscribed to by members throughout the country.

Customs Duties.—A recent Ordinance states that the following duties are now payable on imports into Malta :—

Electrical goods and fancy goods ... articles for ornament, for purposes or partly for use and partly for ornament, 10 per cent. ad val. Chemicals, ironmongery, hardware, iron and steel manufactures, earthenware, glass and glassware, india-rubber and manufactures thereof, motor vehicles, oils and colours, and other goods not enumerated, 5 per cent. ad val.

The following are duty free : Scientific instruments, machinery for industrial purposes, samples of no commercial value, tin, iron, zinc and lead in blocks and sheets, and dutiable articles imported for the public service.

Lectures on Commercial and Industrial Subjects.—Mr. G. H. Roberts (Minister of Labour) and Mr. John Hodge (Minister of Pensions) will deliver lectures in London, the former on April 26, on "A Londoner's Opportunity in Commerce," and the latter on May 3 on "Apprenticeship and Technical Training." Applications for admission should be made to the Education Offices, Victoria Embankment, London, W.C. 2.

Presentation.—Mr. J. M[illegible], mains superintendent at Stoke-on-Trent, has been presented with an illuminated address and a gold watch upon his departure to become deputy electrical engineer and tramways manager at B[illegible].

Will.—The estate of the late Sir John Wolfe Barry, K.C.B., has been valued at £27[illegible] [illegible]

[illegible]

Winding-up Petition.—[illegible]

Tenders Invited and Accepted.

Cooling Tower.

[illegible] Corporation invite tenders for the supply and erection of [illegible] cooling tower. Specifications and [illegible] general manager, [illegible] Offices, [illegible]. Tenders to the town clerk, Mr. H. [illegible] See advertisement.

[illegible]—The Corporation [illegible] accepted the following tenders:—

[illegible] British [illegible] new feeder [illegible] power station [illegible] £520.

Appointments Vacant and Filled.

An electrical engineer is required to take charge of electric supply in Africa. Applications to Mr. W. M. Mordey, 82, Victoria-street, S.W. 1. *See advertisement.*

An advertiser requires an electrical laboratory assistant for standardisation of instruments and materials and general research work.

A mechanician with experience in construction of scientific instruments is required in Ayrshire. *See advertisement.*

A meter test-room assistant is required with good experience. *See advertisement.*

An assistant lecturer attached to the engineering department is required by the City of Hull Education Committee for the day and evening departments of the Municipal Technical College. Salary £175, rising to £250, plus 5s. per hour for evening classes. Forms of application, &c., from Dr. J. T. Riley, Albion-street, Hull.

Applications are invited for the position of operation superintendent in the traffic branch of the London County Council Tramways Department. Salary from £600 to £800. Forms of application from the Clerk of the Council, Spring Gardens, S.W. 1. Applications by 1 p.m. April 15.

Mr. W. Fennell, of St. Albans, has been appointed engineer and secretary of the Northwich Electric Supply Co., in succession to the late Mr. W. Boyd.

Mr. C. W. Crosbie, A.M.I.E.E., has resigned his position with Messrs. Ferranti (Ltd.) in consequence of his appointment as an electrical engineer in the Air Ministry.

Mr. A. E. Cornwell has been appointed manager of the Wireless Workshops, Randwick (N.S.W.).

Business Items.

Dr. J. Erskine Murray, who is now engaged in Government service, has retired from the firm of Clark, Forde, Taylor & Erskine-Murray, and Mr. A. L. Dearlove will be joined by Mr. E. S. Heurtley as a partner in the firm, which will revert to the old style of Clark, Forde & Taylor.

Mr. Heurtley is a member of the Institution of Electrical Engineers, and is well known in the cable world as the inventor of the Heurtley magnifier, relay, and other important inventions in connection with submarine cables.

The London offices of Messrs. Hans Renold, Ltd., have been removed to Bush-lane-chambers, 26 and 27, Bush-lane, Cannon-street, E.C. Telephone, City 8476. Telegrams, "Renolgear Cannon, London."

Messrs. Ferguson, Pailin & Co. (Ltd.), of Openshaw, Manchester, have opened an office at 37, Norfolk-street, Strand, London, W.C. (Telephone: City 547.)

The Enterprise Mfg. Co., Ltd., Gun-street electrical works, Bishopsgate, London, E. 1, which has enlarged its premises, enabling it to double its output, has prepared a list giving particulars and prices of its box blade exhaust fans. They are made in sizes from 12 in. to 36 in., and for all voltages in a.c. and d.c.

Plant for Sale.—An advertiser has for sale two 250 B.H.P., two 100 B.H.P., and one 12 B.H.P. slip-ring type motors.

Patent Development.—The owner of patent No. 8,651/1914, for [illegible] Messrs. E. P. Alexander & Son, 306, High Holborn, London, W.C. 1.

Glue Pots.—[illegible] works, munition factories, &c.

[illegible] be supplied.

Machine Shop Accessories.—Messrs. [illegible] Ltd., [illegible] have issued a pamphlet giving particulars of the machine tools and accessories supplied by them. Copies may be obtained by interested firms.

Companies' Meetings and Reports.

DUBLIN & LUCAN ELECTRIC RAILWAY CO.—At the meeting last week it was reported that, after providing for debenture interest to date, there was an available balance of £603. 19s. 6d. for 1917, out of which the directors recommended the payment of the preference dividend for one half-year, which would absorb £475, leaving £128. 19s. 6d. to be carried forward. The chairman (Mr. J. W. Hill) said the Government had taken over the control of the line on Jan. 1, 1917. Passenger receipts rose from £6,287 in 1916 to £7,010 in 1917; season tickets, £335 to £432; workmen's tickets fell £19 to £16; parcels and cycles rose £534 to £571; goods, £351 to £413; rents from advertisements, £87 to £115; showing a net increase of nearly £1,000. The principal outgoings showed a great increase. The Government made up the net earnings to the level of 1913, but they had enforced the payment by the company of war wages of 20s. or 21s. weekly to every man over 18 years who was previously earning not more than £500 per annum. The cost of the war wage for 1917 was £1,265, and would, if continued for 1918, be more than doubled. Coal increased from £2,573 in 1915 to £3,102 in 1917. The cost of materials had also reached an unprecedented height. The full increase in the expenditure might be taken as almost £3,000.

FOLKESTONE ELECTRICITY SUPPLY CO. (LTD.)—At the meeting to-day (Friday) it was reported that on Dec. 31, 1917, the equivalent of 165,307 8 c.p. lamps was being supplied, an increase of 7,376 8 c.p. lamps over the figures at Dec. 31, 1916. The Company has had to still further increase the price of current owing to the advance in the amounts paid for fuel and labour. Including the receipts from hired installations, the profit amounted to £14,633, with £2,594 brought forward, and interest and installation profits, and after allowing for interest on debenture stock and dividend on preference shares, the balance was £11,405. Out of this an interim dividend at rate of 6 per cent. per annum has been paid on the ordinary shares, and £4,262 was placed to depreciation and £1,000 to reserve fund; and the directors recommended payment of a final dividend at rate of 8 per cent. per annum (less tax) on the ordinary shares for the half-year (making 7 per cent. for the year), leaving £2,643 to carry forward.

W. T. HENLEY'S TELEGRAPH WORKS CO. (LTD.)—The accounts for 1917 show a profit of £238,725. Deducting directors' and auditors' fees, debenture interest, &c., £75,857, and adding £69,730 from 1916, the total is £232,597. After deducting income tax (£28,755), transferring £2,801 to reserve in respect of depreciation of trustee securities, £25,000 to reserve account, and £5,000 to special war allowance reserve account, paying dividend on preference shares (£9,000) and interim dividend on ordinary shares (£10,000), the available balance is £152,042. The directors recommend payment of a final dividend on the ordinary shares of 10 per cent. (less tax), making 15 per cent. for the year, and also a bonus of 10s. per share (less tax); this will require £40,000, and leave £112,042 to be carried forward. Provision has again been made for special depreciation on the machinery in the factories which has been running day and night on Government work, and for machinery which has been bought specially for war purposes which will be useless, or of problematical value, after the war. Subject to the consent of the shareholders, the Company propose to subdivide the £5 ordinary shares into £1 shares, and to form a Tyre Company having a share capital of £200,000, the whole of which will be held by the Company; also to increase the ordinary share capital of the Company by £200,000, and to distribute that amount in fully paid shares as a bonus amongst the ordinary shareholders. The consent of H.M. Treasury has been obtained to the issue of the £200,000 ordinary shares, but authority to issue shares of the Tyre Company has not yet been received. Owing to advanced age Mr. Sydney Gedge has relinquished his position as chairman of the Company, and Mr. George Sutton has been appointed in his place and now holds the position of chairman and managing director. The Company will still have the benefit of the long experience of Mr. Gedge upon the board.

New Companies.

BRITISH CELLULOSE & CHEMICAL MFG. (PARENT) CO. (LTD.) [illegible] Reg. Nov. 29, capital £3,500,000 in £1 shares [illegible] debentures, [illegible] British Cellulose & Chemical Mfg. Co. (Ltd.) or any other [illegible] manufacturers, producers, [illegible] wholesale and retail dealers in [illegible] preparations [illegible] &c.; also [illegible] and to enter [illegible] W. G. Morden, [illegible] Bart., [illegible] [illegible]

FRICKERS METAL CO. (LTD.) [illegible] Reg. [illegible] capital [illegible] to take over the business of [illegible] electrical [illegible] Miller and J. A. [illegible] Langley Metal Works, Langley street, Luton, Beds.

UNITED STEEL COMPANIES (LTD.)—Reg. with nominal capital of £7,680,000 in £1 shares (1,330,000 original preference and 6,350,000 ordinary), to acquire all or any of the preference and ordinary shares of Steel, Peach & Tozer (Ltd.), Samuel Fox & Co. (Ltd.), Frodingham Iron & Steel Co. (Ltd.), Appleby Iron Co. (Ltd.), Workington Iron & Steel Co. (Ltd.), and the Rother Vale Collieries (Ltd.), to enter into an agreement with the Imperial & Foreign Corpn. (Ltd.), and to take over the business of iron and steel manufacturers, mine owners and colliery proprietors carried on by above companies; also to carry on the business of manufacturers of and dealers in coke and other products of the carbonisation of coal, manufacturers of coal briquettes and patent fuel, chemical manufacturers, electrical engineers, shipbuilders, &c. First directors are Hy. Steel, Wm. Steel, Wm. Tozer, A. O. Peech, J. Peech, T. Jowett, W. Chesterman, H. Barber, F. S. Scott-Smith, F. J. Jones and W. Benton Jones.

WAGON REPAIRS (LTD.) (150,042.)—Reg. with a nominal capital of £1,250,000 in £1 shares (500,000 7½ cumulative preference and 750,000 ordinary). Objects: Repairers, rebuilders, renovators and adaptors of railway and other wagons, trucks, carriages, trollies, tramway cars and bogies, motor, electric, gas, steam and other vehicles, &c. The signatories include: Birmingham Railway Carriage & Wagon Co., British Wagon Co., S. J. Claye (Ltd.), Gloucester Railway Carriage & Wagon Co., Harrison & Camm, Hurst, Nelson & Co., Metropolitan Carriage, Wagon & Finance Co., Midland Railway Carriage and Wagon Co. and North Central Wagon Co.

City Notes.

BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. (LTD.)—The directors have decided to recommend payment of a dividend of 7½ per cent. on the preference shares for the year ended Dec. 31 last.

ELECTRIC SUPPLY CO. OF VICTORIA (LTD.)—The Tramway and Electricity receipts for the three months ended Dec. 31 last were £23,249, and the expenses £16,328.

SAO PAULO TRAMWAY, LIGHT & POWER CO. (LTD.)—The directors have declared a dividend of 2½ per cent. on the common stock.

WEST KOOTENAY POWER & LIGHT CO. (LTD.)—The net revenue for the year ended Aug. 31 was $448,714. After providing for interest and sinking fund, reserving $99,736 for depreciation, and paying 7½ per cent. on the common shares (against 5 per cent. for each of the three preceding years), the credit balance is $433,398.

WILLANS & ROBINSON (LTD.)—The directors, after consultation with the board of Dick, Kerr & Co. (which holds the majority of the shares in the Company) propose to modify the arrangement with the "B" preference stockholders.

The Round Table.

By "kVA."

The following from the second issue of "The Chloride Chronicle" is a real gem:—

"Export Department gets some very pretty conundrums to solve in the course of the year, but the following, which recently arrived from a Neutral country, is particularly subtle:—

"'Remarking your advertisement in THE ELECTRICIAN, we here with beg to request for description of and statement of prices for electrocares, so that we, when the question of procuring will be actually, can have maked up our mind of which types we will use. Especially may it be interested to get the question—electrocares contra benzincares elucidated.

"'Of cares which we are interested in, may mention spares stores, cares for transport of goods from business and customers, the largers cares for loading sand, stones and such like, and also cares for streets cultivation, such as water-cart, road rollers, &c.

"'For your orientation we beg to notice that the total length of the town are about five km. with normale gradientilines. We are, Dear Sirs, &c.'

"For ourselves, we are content with the 'cares' of a back garden; we shall never attempt anything so ambitious as 'streets cultivation.'"

* * * *

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, April 9, 1881.]

THE ELECTRIC RAILWAY AT BERLIN. A telegram from Berlin, dated Wednesday night, says: "The trial trip on the electric railway from Lichterfelde to the Central Cadet Institution was successfully performed this morning. Messrs. Siemens & Halske have accomplished a complete triumph."

FALL OF A METEORITE. A meteoric stone fell near Northallerton (Yorkshire) on March 14th last, and was exhumed by some labourers, being quite warm when taken from the ground. Its fall was accompanied by a loud rumbling noise, which was heard at some distance. The sky was quite clear and the air cold.

EARTHQUAKE AT CHIO. During the panic caused by the recent disastrous earthquake at Chio, in which 3,000 persons are reported to have lost their lives, the Eastern Company's telegraph station was broken open and pillaged. Later intelligence says: The Eastern Company's office is nearly destroyed, and the clerks are working temporarily from the landing place of the cable.

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

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CONTENTS.

Notes.

Science in Education.

THERE has at length been issued the report of the Committee appointed by the Prime Minister in August 1916 to inquire into the position occupied by natural science in the educational system of Great Britain. The Chairman was Sir J. J. THOMSON and the Committee included a number of well known people concerned with education in one form or another. One of the general conclusions of the Committee is that natural science should be included in the course of education for all pupils up to the age of about 16 and that the tests of such a course should be accepted as normal qualifications for entrance to the universities and the professions. This appears to imply a raising of the school standard and would require similar action in regard to languages. It is suggested that there should be no division of schools into sides at the 12-16 stage. For pupils under 16 it is proposed that more attention should be given to those aspects of science which bear directly on the objects and experience of everyday life. We fully agree with this view. To the youthful mind it is the experiences of everyday life that appeal and that require explanation, and much greater interest can be aroused in science if it is used for the purpose of such explanation rather than in a more abstract way. The ordinary candle, for example, is a centre of chemistry in itself and has been so used to great advantage. It is also stated that the present use of English weights and measures causes a waste of time and confusion of thought, and that there are good reasons for the adoption of the metric system. Apart from the merits of the metric system, we certainly think that much useful time is wasted on such weights and measures. These depend essentially on vulgar fractions, and such fractions monopolise the time to such a large extent that decimals are frequently looked upon as a mystery and carefully avoided. Obviously, this frame of mind should be rectified, but this will not be done so long as English weights and measures are looked upon as being of great importance. From the point of view of education it is better to have a ready mental conception of the meaning of, say, 0·333 rather than to work out areas in poles and perches. We are also glad to see that the report lays stress upon the need of the accurate use of the English language. The general lack of acquaintance with our own language is little short of a scandal, and is chiefly due to the old-fashioned classical idea that Latin and Greek are more important than a modern language depending upon them. It is suggested that after the age of 16 specialised study should be adopted, the specialised subject taking up not less than one-half, nor more than two-thirds, of the school work.

Science in the Civil Service.

THERE has been a good deal of discussion recently on the question of science in the Civil Service, where undoubtedly it has been very lacking. In the present report it is pointed out that many prominent posts can best be filled by men selected not by the ordinary competitive examination but at a riper age on the ground of high scientific qualifications and professional experience. As to how far this is practicable we do not know. It will certainly present some difficulties to the official mind, and will not be looked upon with favour at any time by those who will regard a newcomer under these circumstances as an intruder and as one who will interfere with ordinary promotion. At the same time, there is a good deal to be said in favour of men being employed in the Civil Service who have not been brought up in the surroundings of red tape and who, therefore, are prepared to look at things from an ordinary point of view. Lastly, there is the question of the supply of scientific workers for industry. Here it is largely a question of opportunity for the student on the one hand and good teaching on the other, the latter of which can only be secured by paying teachers adequate salaries. Possibly these requirements will be attained in due time when our educational system has been revised by Parliamentary action. Of course, it must be realised, and we think it has been realised by this Committee, that science is not the only thing in life; nor has every pupil the type of mind which can do its best work on scientific lines. What is necessary is that those who have a scientific bent should be encouraged to take up the science side as a vocation. This does not mean that the "humanities" should be neglected or that those who have a taste purely for languages and art should in any way be discouraged. In our education we must, above all things, have a proper balance in our aims.

Medical Electricity.

THE last meeting of the Institution of Electrical Engineers which was held jointly with the Electrical Section of the Royal Society of Medicine was distinctly successful. It gave members an opportunity of looking at some problems which at least can be considered by a joint discussion, and which are of mutual interest. We do not doubt that much greater progress would be made in various directions if there were greater combination between kindred interests instead of rigid specialisation. Meetings of this kind give electrical engineers an opportunity of seeing whether they may be

useful in solving interesting, and often urgent, problems of which they would otherwise be ignorant. One of the Papers read at this meeting was by Mr. E. P. CUMBERBATCH on the subject of "Diathermy." The Paper describes the use of high-frequency currents for heating the tissues. As to the results obtained we have nothing to say, for sufficient heat appears to be generated in the joints and other parts by the passage of a current of, say, 1 ampere to have the desired medical effects. When, however, the view is expressed that the heating is due to the passage of this current through the tissues, we confess to some scepticism. The electrical engineer will probably feel that a high-frequency current will not penetrate sufficiently to give this heating effect directly, and that the heat must be generated on the surface. Even if this is the case, however, it does not follow that ordinary surface heating would be as effectual from the medical point of view. The second Paper, by Dr. ROBERT KNOX, dealt with the interesting subject of instantaneous radiography. For such a purpose it is necessary to produce intense radiation for a very short period. Here the self-induction of the coil presents a difficulty. A good deal has already been done, but so far the results obtainable are not sufficient to meet the needs of the medical world, and the problem is essentially one for the electrical engineer. We commend it to our readers for their consideration.

Encouraging the Inventor.

THE announcement in the "Elektrotechnische Zeitschrift" that a new body, termed the German Institute of Invention (Deutsches Erfindungsinstitute), has been formed in Giesen in order to give assistance, pecuniary and otherwise, to inventors shows that, in Germany at least, the value of the inventor is being realised. The objects of the new Institute include the testing of inventions from the standpoint of technical value; the promotion and protection of useful inventions and their application to industrial, naval and military purposes; the formation of students' societies; the collection and publication of information on inventions; the issuing of descriptions, catalogues, &c., relating to inventions; and the assistance of invention and discovery by pecuniary grants for such purposes as education, travelling scholarships, &c. We think it will be agreed that such an institute, if wisely administered, will be of considerable assistance to the inventor, and may be of great advantage to German industry. The average independent inventor who has the misfortune to be without financial backing stands practically no chance in this country, even though his invention may be of technical value. We think that a corresponding body in this country would do much good. Undoubtedly it would be bombarded [illegible] rendered useful instead of dormant.

Military Information and the Press.

[illegible] United States [illegible] W. [illegible] United States [illegible]

public property and unfounded rumours removed. This seems a judicious step, but we notice that the United States is apparently not escaping the conflict of interests between different Departments, which seems to be almost inseparable from a state of war. Although the value of the Press is thus recognised, a rise in postal rates, which will be very burdensome to technical papers, seems to be in contemplation. It will be recalled that similar propositions were entertained in this country shortly after the war, but were eventually modified. All will agree that at a time like the present the dissemination of scientific and technical information is a national asset. This is surely one of the last directions in which taxation should be applied.

Waste of Paper.—Any of our readers who are aware of cases where paper is being wasted are asked to communicate by letter with the Paper Controller, 23, Buckingham Gate, London, S.W.

Institute of Metals.—The May lecture before the Institute of Metals will be delivered on the 2nd prox. by Sir Charles Parsons, who will deal with the artificial formation of diamonds. Those who desire to be present should apply (enclosing a stamped addressed envelope) to the secretary, Mr. G. Shaw Scott, M.Sc., 36, Victoria-street, London, S.W. 1.

Transcations of the Institution of Engineers and Shipbuilders in Scotland.—Part III., Vol. LXI., of the above "Transactions" contains a series of Papers dealing with industrial and educational problems. These comprise discussions on "The Premium Bonus System," by Mr. W. H. Riddlesworth; "Apprenticeship Training," by Mr. A. P. M. Fleming; and the Paper by Mr. J. Richardson on "The Question of Scientific Management" and discussion thereof.

I.E.E. Wiring Rules—The Council have adopted a recommendation of the Wiring Rules Committee that wiring rule No. 62 shall not apply to consumers' electric supply meters for currents up to 100 amperes made in accordance with the Engineering Standards Committee's specification No. 37. The rule to which reference is made is to the effect that conductors of larger cross-sectional area than that of a 7/18 S.W.G. cable must be soldered into proper cable thimbles for connection to the terminals.

Electrical Hoist Manufacturers' Association.—In view of the unprecedented demand for electric hoists and similar plant, and the desirability of standardisation, manufacturers in the United States have formed themselves into an association, which at its last meeting offered the services of the member companies to the Government. Monthly meetings are being held, with a view to developing standardised methods of presenting information, uniform nomenclature and the collection of statistical data on the applications and properties of electrical hoists.

Magneto Portable Lamps in the German Army.—According to "L'Industrie Electrique," magneto-operated portable lamps are finding favour in the German army, and a description is given of several such devices recovered from the enemy. They are operated by springs kept in tension by the action of the fingers and have certain advantages over torches using batteries. The chief drawback is the weight. The most successful lamps which contain a reserve of energy sufficient to afford 10 minutes light without hand-action being brought into play weigh about 3¼ lb.

Hysteresis Loss.—No. 4, Vol. VI., of the Science Reports of the Tokyo Imperial University contains several communications on electrical and magnetic researches. Messrs. K. Honda and J. Okubo develop a theory of hysteresis loss by magnetisation which is supplementary to earlier contributions by the same authors discussing Ewing's theory of molecular magnetism. According to the view expressed by the authors hysteresis loss only takes place when the rotation of the molecular magnets caused by the external field is discon-

tinuous. Other Papers of interest are those by K. Honda and T. Simidu on "Thermal and Electrical Conductivities of Carbon Steels at High Temperatures," and by K. Honda on "A Criterion for Allotropic Transformations of Iron at High temperatures."

Railway Electrification and Coal Saving.—Mr. E. W. Rice, President of the American Institute of Electrical Engineers, recently referred to the value of railway electrification as a possible future opening for coal-saving in the United States. Much had been said on the economising to be made by cutting down lighting, which, however, was only responsible for 2 per cent. of the total coal consumption. But the consumption by steam-driven railways amounted to 25 per cent. of the total coal mined, and the coal was used under such inefficient conditions that 6 lb. were required per horse-power-hour. Electric traction could boast an efficiency three times as high. Accordingly, if all railways were converted to electricity a saving of 16⅔ per cent. of the total coal consumption could eventually be made—far more than could be achieved by suppressing lighting altogether.

The Association of Great Britain and France (Industry and Economics).—This association corresponds to the "Association France-Grande-Bretagne," on the other side of the Channel, which was founded with a view to making better known among friendly countries the ideals and specially the economic aims of France, in order that true reciprocity founded on mutual understanding may be established.

The work of the association commenced in April last, and since that date the efforts of the Management Committee have been directed to [illegible] membership, and it now counts among its supporters some of the most prominent firms and trade associations in the kingdom. It has been felt that the time has come for the association to have its own quarters and an independent organisation. It has been resolved, therefore, to appeal to that wider public of both men and women whose sympathies or interests are affected by the industrial, commercial or agricultural intercourse of the two countries. The subscription is two guineas. Information regarding the association may be obtained from the Secretary, 39, St. James's-street, London, S.W. 1.

The Maintenance of Electric Locomotives.—The ease with which the most recently designed electric locomotives can be maintained and supervised was somewhat strikingly illustrated by a description in a recent issue of the "Electric Railway Journal," of the experiences of the Butte, Anaconda & Pacific Railway. This is mentioned as the first indication that 2,400-volt direct-current system can be applied to great tonnage. Trains of 75 ore-laden cars, each averaging 68 tons or more, are not uncommon. There are now 26 of these locomotives in use, those of the freight type weighing 82 tons each. There are also three tractor trucks of about half the weight. It is stated that the electrical maintenance of all the locomotives and tractor trucks is undertaken by three men, two electricians and an assistant. This small staff does all rewinding, and only one commutator has ever been sent to the factory. The staff also attends to car heating and lighting equipment. It is remarked that it would hardly be possible for the supervision to be done by such a small staff on a steam system. Passenger locomotives are inspected electrically and mechanically every [illegible] days, and freight engines every 30 to 40 days. [illegible] of the period of inspection.

The Catalytic Action of Carbon in Batteries.—M. Féry, whose researches on primary batteries we have referred to recently, has contributed to the Société Internationale des Electriciens an interesting communication on the part played by carbon as a catalytic agent in Leclanché cells. Depolarisation is effected through the action of the air, but the part played by the carbon in the process is somewhat obscure. At first sight it would appear that the only factors of importance in facilitating the catalytic action of carbon in conveying oxygen from the air are the nature of its surface and its porosity. But experiments have shown that the constitution of the carbon is also of importance. Seeing that all catalytic agents are affected by the presence of small impurities, it is hardly surprising that carbons apparently similar differ widely in their behaviour. Moreover, certain qualities of salammoniac, containing traces of iron and lead also hinder the action of catalysis. The presence in the pores of the carbon of a gelatinous film of metallic hydroxide has a prejudicial effect. The purity of the carbon is therefore a vital factor. Some results are given for batteries using the special carbons manufactured by the Société Gallot as a result of M. Féry's researches. A battery containing 100 gms. of salammoniac, in volume about 1 litre of solution, with 77 gms. of zinc, and supplying 20·8 milliamperes (0·5 ampere-hour per day) consumes 1·27 gms. of zinc per ampere-hour, as compared with a theoretical consumption of 1·2186 gms. The efficiency was thus near 95 per cent. The consumption of salammoniac was also much reduced, being only 1 gm. per ampere-hour. If the above current is maintained by adjusting the external resistance the P.D. falls from 1 volt to 0·5 volt in four months, and the cell will then continue in action if the zinc is reversed.

Obituary.

SEÑOR SALDAÑA.—The death is announced of Señor Saldaña, Director of Posts and Telegraphs of Uruguay.

E. W. FARNALL.—We regret to record the death of Mr. Edmund Waterton Farnall, C.B., on April 14th.

Mr. Farnall had been employed in the General Post Office for 42 years, and had been one of the assistant secretaries since 1903. In 1912 he was the British plenipotentiary to the International Wireless Conference

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Personal.

Mr. A. Hugh Seabrook, manager of the Marylebone (London) electricity undertaking, has resigned that position in order to take up a position of national importance.

Mr. J. A. Blackwood intimates that he has severed his connection with the Union Cable Co. (Ltd.) [illegible] director, and has joined the board of the [illegible] Cable Co. (Ltd.).

WAR CASUALTIES.—The following casualties are reported:—

Sec.-Lieut. A. D. Moore (Essex Regt.), formerly in the employ of the India Rubber Co., Silvertown, was killed on 23rd ult.

Corp. J. H. Flett (R.F.), also a former employee of the India Rubber Co., has been wounded and missing since Nov. 30 last.

Sergt. A. H. Taylor (R.F.A.), formerly in the Waterproofing Dept. of the India Rubber Co., has been wounded, and Pte. W. [illegible] (Middlesex Regt.), formerly in the company's [illegible] office, is a prisoner of war.

Pte. H. [illegible], formerly a Blackpool Corporation tramway employee, has been wounded.

Arrangements for the Week.

FRIDAY, April 19th (to-day).

[illegible]

TUESDAY, April 23rd.

[illegible]

WEDNESDAY, April 24th.

[illegible]

THURSDAY, April 25th.

[illegible]

FRIDAY, April 26th.

[illegible]

The Commutator Machine as the Standard Single-Phase Type.*

By F. CREEDY.

The author advances claims for the universal employment of the commutator motor on single-phase circuits to the exclusion of the single-phase induction motor.

The single-phase system is not dying out, as some people think. In fact, it has its own field like other systems. Within its own field it is superior to all others, and with the extension of that field the system will extend. This field is to be found in residential districts, and, in fact, in all parts where the motor load is not the predominating feature. For such districts the three lines of the three-phase system are superfluous and lead to the use of needless cable and switchgear, so that up to the present, owing to the absence of a satisfactory single-phase motor, new schemes for such districts have often been on the direct-current system in spite of the impossibility of using high-tension transmission. With the growth of heating and cooking loads, such districts will become large power consumers, and for all these purposes, single-phase power, preferably derived from a large polyphase power supply by sub-dividing the phases on a local switchboard, is pre-eminently suitable. If the comparatively limited demand for motors in such districts can be met by a machine having characteristics not sensibly inferior to those of direct-current or polyphase machines the single-phase system becomes free to expand as the natural adjunct to the polyphase system in districts for which it is suitable, without the designer of the system being handicapped by the knowledge that the motor demand cannot be met satisfactorily. It is hoped to show below that the single-phase commutator motor has now reached a stage of development where its characteristics are sensibly equal in every way to those of direct current or polyphase motors.

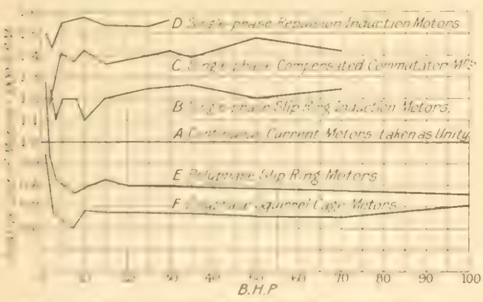

Fig. 1.—[illegible] Types of Motor.

[illegible] of the various types [illegible] compared with direct current or [illegible] it will probably be [illegible]

[illegible] type of motor, the [illegible] that the com[illegible] per cent. more [illegible]

[illegible]

[illegible] per min. for single-[illegible]

* [illegible]

one our best known manufacturers; also shipping weights. While the efficiency does not reach quite such high figures as in direct-current motors, being about 5 per cent. lower in sizes of less than 10 H.P., the difference gradually diminishing to 3 per cent. in motors of 35 H.P., the difference is of quite a minor nature, a greater difference of efficiency existing, even in a direct-current motor, according to whether it is fully or only fractionally loaded. The shipping weight of the single phase motor is uniformly lower than that of the direct-current motor by about 10 per cent.

There has been a remarkable advance in design during the last 10 years. This is partly due to improved carbon brushes, which can now be run at a current density of 60-65 amperes per square inch, compared with 30 amperes. Another reason is that early motors consisted essentially of a single-phase induction motor, with a wound rotor to which a commutator had been added; that is, they were proportioned in the same way at a single phase induction motor. An exact comprehension of the operation of the machine has led to a complete change in the balance of design, with corresponding economies both in losses and the use of materials.

Another current misconception is as regards the commutation of the single-phase commutator machines. They were supposed to spark a great deal. Actually the commutation fully comes up to the most exacting standards of direct-current commutation. A further fallacy is the idea that an extra cost is incurred by compensating machines to give unity power factor. So far from this being true, the very opposite is the case, the compensated machine, owing to its superior overload capacity, and the reduction of from 15 to 20 per cent. in the current, leading to a reduction of from 28 to 36 per cent. in the copper losses, is capable of giving a considerably larger horse-power than a machine of the same dimensions which does not operate at unity power factor.

The direct importance of high power factor to the supply company's engineer scarcely needs pointing out, as it is well known that the single-phase supply station is afflicted with a very low power factor, frequently not above 0·5. This is due solely to the large number of split-phase motors usually found on the circuit, the majority of which are operating at fractional load, which involves, of course, power factor far less than the low value which is obtained at full load, the compensated motor reaches a very high power factor. Hence it is believed that the single-phase supply engineers will gradually endeavour to supplant the split-phase motor by the compensated type, which will have the effect, were it used exclusively, of raising the station power factor, say to 0·9, thereby nearly doubling the capacity both of the cables and the generating plant; in fact, proposals have already been put forward for granting a preferential tariff to the users of high-power factor, and in some districts it is already the practice for consumers to be charged on a kilovolt-ampere basis.

The reduction in size and weight of the single-phase, as compared with the direct-current machine, is due to the substitution of the light laminated core, and cast-iron housing for the heavy yoke, poles and shunt coils of the direct-current machine. Continuing the comparison with the direct-current machine we find on examining the brush gear that it is divided into two sets, one completely short-circuited in most types of motor, the other brought out to a pair of terminals. The latter set contains only about half the contact surface of the former set, and is spaced half a pole pitch away from it on the commutator surface. Without for the moment describing the connection of the starting gear in detail, it will be noted that at starting, the rotor terminals are completely open circuited, or else closed through a choking coil, while, as the machine speeds up, the rotor circuit is closed through an auxiliary stator winding, or the secondary of a transformer. In some special instances the starting resistance is merely cut out, or by means of special design it is possible for the motor to operate from starting to full speed without change of connections.

During the starting period, if the rotor circuit is completely open, the motor operates as a pure repulsion motor, that is, it has characteristics similar to those of a direct-current series motor. In order to describe the transition from such a series motor to the repulsion motor, we may refer to the diagram of Fig. 2.

The compensating windings have the effect of preventing the distortion of the field of the direct-current machine under load and of improving the commutation. The chief defect of the neutralised

series motor for use with circuits of normal frequency is the fact that the voltage across the commutator is nearly equal to that across the line. For a motor, therefore, which it is desired to operate at 400 volts, 50 cycles, this would involve absolutely impossible commutating conditions. To overcome this difficulty it is desirable to render the commutator voltage independent of the line voltage, by making use of the possibility of voltage transformation in the alternating-current circuit. Accordingly, instead of connecting the armature in series with the neutralising winding, we short circuit it, and connect the field and neutralising winding in series across the line, as shown in diagram C. The armature now receives its current by transformation from what was before the neutralising winding which now acts as primary to the armature as secondary. It is now possible to choose the armature winding to suit the requirements of commutation, without in any way considering the line voltage.

The two windings shown in Fig. 2, namely, the field and neutralising winding, may be compounded or combined, into a single winding which is displaced by a certain angle from the magnetic axis of the motor winding, and this is, for manufacturing reasons, the most convenient method of constructing non-reversible motors.

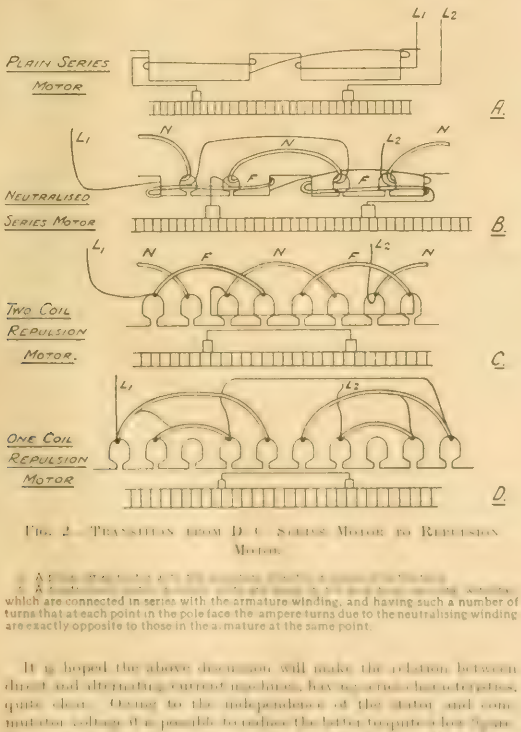

FIG. 2.—TRANSITION FROM D.C. SERIES MOTOR TO REPULSION MOTOR.

[illegible] which are connected in series with the armature winding, and having such a number of turns that at each point in the pole face the ampere turns due to the neutralising winding are exactly opposite to those in the armature at the same point.

[illegible]

circuit after the rotor circuit has closed. But by inserting reactance in the shunt circuit, its strength and relation to the series circuit may be regulated so as to give any amount of compound desired.

The writer has often been asked by users of this type of machine to explain how it is that it is capable of having its power factor set to the value of unity, or even arranged to give a leading current. This is a very difficult question to answer in a simple and intelligible way.

One other type of motor exists having an adjustable power factor, viz., the synchronous motor, whether single or polyphase. This type has a stator winding exactly similar to that of the compensated commutator motor, and a revolving field excited with direct current. Now, imagine this revolving field replaced by a commutator armature with a polyphase distribution of brushes. Imagine a polyphase current of normal frequency led through these brushes, and that the rotor is revolving at synchronous speed. These revolving currents produce a revolving field, rotating at the same rate as the rotor, and hence not cutting it. This field therefore will produce no back E.M.F. in the brush circuits, and the current therein will be determined purely by Ohm's law, just as it is in the field of the synchronous motor. In fact, the effect of the commutator running in synchronism is to rectify the polyphase current and supply a constant current in each slot of the rotor winding, this current varying from slot to slot in such a way as to produce identically the same field as that which was before produced by the revolving field of the synchronous machine.

The strength of this field may be regulated by varying the applied voltage by means of tappings on a small transformer, just as it is in the synchronous machine by a field rheostat. Hence, from this point of view, the commutator may be regarded as a device for rectifying the field current in the rotor. This, perhaps, gives a fairly simple explanation of the relation between the method of compensating for low power factor by means of the polyphase commutator machine, and by means of the synchronous machine. To explain in detail how compensation is possible with single-phase currents only is beyond the scope of this Paper.

In regard to starting, it should be noted that small single-phase machines, say less than 3 H.P., are usually thrown direct across the line by means of a double pole switch. Above this size the regulations of many supply companies renders a starting current, such as that quoted above, objectionable, besides which, where the motor has to start on light load, the acceleration will be far too rapid unless some steps are taken to reduce the voltage at starting. The most convenient method of doing this is by means of some type of two-point starter, having a starting position in which either reduced voltage derived from an auto-transformer, is applied to the motor, or a resistance, or inductance, put in series with it. The rotor circuit meanwhile is open or closed only through a reactance. In the running position full voltage is applied and the rotor circuit closed. It is found that with such two-point starters motors of any [illegible] great a current, the switchgear employed being of the simplest possible description.

(*To be concluded.*)

Electric Production of Pig Iron in Northern Sweden.—In "Engineering" [illegible]

The Overseas Distribution of Engineering Appliances.*

By LEONARD ANDREWS.

Experience has shown that the country which carries out any original engineering work abroad usually secures the bulk of the subsequent trade of that country created by the industries thus established. There can be little doubt that the engineering industries meet the above requirements more fully than any other. It is therefore a matter of the greatest national importance that British engineering industries should be fostered and developed to the fullest possible extent, and that, if necessary, State funds or credit should be applied to this purpose.

It would almost appear that both Germany and America—having recognised the strength of this country's position as a producer—decided to concentrate their attention upon improving distribution, and have thereby attained an exceedingly high state of efficiency in that particular respect.

That mere efficiency of production is, comparatively, of little value unless combined with efficiency of distribution is well exemplified by the history of the electrical industry. There is probably no other industry in which the question of efficient distribution has been treated as an exact science to a greater extent than in that of electricity supply. The author, therefore, ventures to suggest that, as many of the problems associated with overseas trade are so closely analogous to the difficulties which have been successfully overcome in distributing electrical energy, the past experiences of electrical engineers should enable them to render valuable assistance to the executive officers of the various organisations which at the present time are devoting so much attention to the improvement of British foreign trade.

Bulk Supply.—The principles of bulk supply have been applied extensively in the United States and in Germany (also to a limited extent in this country) to the production and distribution of many products other than electric power. The principle on which these bulk supply schemes is founded is economically sound, and they should therefore be to the advantage of the community, since they tend to eliminate a large amount of the wasted energy at present expended upon useless competition between individual firms. This wasted energy is, of course, eventually paid for by the consumer.

State or Private Enterprise Control.—The need for more perfect co-ordination between individual producers and between producers and distributors is now freely admitted. There are, however, considerable differences of opinion as to whether the centre of such co-ordination or control should be the State or some private enterprise, such as an association of manufacturers, or, alternatively, some [illegible]

[illegible] control is that any such undertaking [illegible] its productive capacity. The objections to State control are: (1) Such control would be liable [illegible] the employment of [illegible] would generally [illegible] the principals of the aims [illegible]

It appears that actual production, at least, should be left to [illegible] controlled, though a closer [illegible] effected [illegible] the proposed Trade Parliaments, is undoubtedly to be desired. Some more direct [illegible] but [illegible] private enterprise [illegible] of [illegible] prove to be the [illegible]

[illegible]

many intricate problems associated with overseas trade. At the same time, they should be entirely untrammelled by any unnecessary restrictions in the management of their respective businesses in which they, and they alone, are experts.

Co-ordination.

There are at the present time so many organisations devoting their attention to the problems of co-ordinating and reconstructing industry—particularly the engineering trades—that it is difficult to follow and keep in touch with the various projects which are being formulated. Of the State and private enterprise undertakings dealing with this matter the following are, perhaps, the best known:—

The Ministry of Reconstruction.
The Board of Trade, Foreign Office and Consular Service.
The Chambers of Commerce.
The British Engineering Standards Committee.
The Federation of British Industries, &c.

Whilst these organisations are attacking the problem from different aspects, they are all aiming at a common objective. It appears to be, therefore, a primary necessity that their efforts in this direction should be all co-ordinated under one central control which would be the universally recognised centre for all matters relating to overseas engineering trade. This central board might advantageously consist of a representative of each of the individual organisations referred to above, with the addition of a representative of existing shipping merchant interests. The primary object of the board should be to endeavour to maintain a constant balance between the factors of British supply and overseas demand, for which purpose it is necessary that its members should be kept constantly informed as to (*a*) what are the predominant existing or potential demands of each of the various overseas markets, and (*b*) what is the nature and extent of the productive capacity of each of the engineering manufacturing units in this country.

Information under category (*a*) would be obtainable from the existing records and statistics of the Commercial Intelligence Department of the Board of Trade. The more detailed information upon which future trade must principally depend can, however, only be obtained satisfactorily through the medium of organised selling forces actually trading in each of the respective districts from which information is required, such as the established overseas branches of city shipping merchants, or distributing centres must be organised.

Very complete information respecting the productive capacity of engineering works throughout the country is already in the possession of the several "Munitions Area Boards of Management" created by the Ministry of Munitions for the purpose of procuring the maximum output of war material.

Distribution.

To provide for anything approaching efficient distribution of engineering appliances it is necessary that in every overseas industrial centre a complete distributing organisation shall be established, consisting of a business general manager, an engineering staff, a number of sub-district salesmen (preferably local men well known to every potential buyer in the particular sub-district allotted to them), an accountancy and credit department, adequate clerical assistance, warehouse and showroom or exhibition accommodation, &c.

The managers of the respective distributing centres should be men possessing tact, initiative, judgment and resource, as well as a wide [illegible] knowledge. They must be given absolute authority to enter into and execute all contracts without reference to headquarters, though they should report to the Central Board all transactions completed each week. The engineering staff should consist of men who have been trained in engineering works in this country. The sub-district salesmen (or local travellers) would be allotted separate areas to work, and their sole aim would be to procure the [illegible] possible turnover in British made appliances without favouring the products of any individual firm.

A sound and trustworthy credit department is an absolutely [illegible] adjunct to every overseas distributing centre. Every wholesale distributor submits all important orders before executing them to his credit manager, who either knows or has means of ascertaining what is the financial position of every buyer, or prospective buyer, in the territory. An important institution in Canada is the Canadian Credit Men's Association, with a membership of considerably over 1,000 representatives of the principal wholesale distributing houses scattered over the entire Dominion. The [illegible] object of the organisation is to render more stable and [illegible] the wholesale credit trade of the country. The author has

[illegible]

had an insight into the exceedingly valuable work this institution is carrying out, and he is confident that, under the guidance of the association and with the help of an efficient credit department at each Canadian distributing centre, the risk of excessive bad debts through trading in engineering appliances is small.

The pricing and estimating department is possibly the most indispensable section of an overseas distributing centre. It must deal with plant erected on site, the organising of an efficient overseas estimating department, with the necessary preliminary collection and recording of manufacturers' f.o.b. costs, shipping weights and dimensions, ocean and inland freight charges (which are constantly changing), Customs and insurance charges, and complete technical data is a very laborious and costly proceeding.

Extensive warehouse accommodation must be provided at every distributing centre of sufficient capacity to provide for carrying a large and varied stock of those appliances for which there is a reasonably big demand. Quite apart from the necessity of being in a position to make immediate deliveries from stock, a very considerable saving in freightage charges can be effected by importing goods in car-load (10 tons) lots.

OPERATING COSTS OF OVERSEAS DISTRIBUTING CENTRES.

As very few people in this country appear to have any idea of the cost of running an overseas distributing centre (manufacturers frequently suggest 5 per cent. as an adequate selling commission), the particulars of a year's costs, shown in Table I., actually incurred in one of the industrial centres of Canada, may be of general interest. Every item of cost was constantly and closely scrutinised and reduced to a minimum consistent with the large area to be covered.

Table I.

Rent, rates, taxes and insurances	£1,205
Salaries—management, engineering and clerical	2,482
Salaries, salesmen and travelling expenses	1,793
Packing and delivery charges	764
Office supplies, advertising, legal and general expenses	572
Bank charges, interest, discount and exchange	310
Postage, telephone and telegrams	241
Depreciation and bad debts	396
	£7,763

Total turnover during period covered by above operating costs —£30,013.

Ratio of operating cost to turnover 25·8 per cent.

Gross profit £7,012 = 23·4 per cent. of turnover.

[illegible]

[illegible]

[illegible]

(To be concluded.)

45,000 kw. Turbine.*

A 45,000 kw. turbine generator set has recently been placed in operation at the South street steam plant of the Narragansett Electric Lighting Co., Providence, R.I. (U.S.A.), increasing the generating capacity of the station to about 80,000 kw. The new machine, believed to be the largest size to be placed in operation in the world to date, more than doubles the station rating.

The Narragansett Company is the largest central station from which the New England Power Co. purchases energy, and is at present selling the latter company over 2,000,000 kw. hours per week.

The new unit was built by the Westinghouse company. It is of the cross-compound type, consisting of a high-pressure turbine exhausting into a low-pressure turbine, the former running at 1,800 revs. per min. and the latter at 1,200 revs. per min. Each drives a direct-connected generator of 22,500 kw. rating, delivering 11,000 volt three-phase 60 cycle energy and designed to divide the load equally between the two. The unit is supported on a structural steel foundation, weighing about 515,000 lb. (233,600 kg.), the foundation being carried on a pile and concrete foundation formerly supporting a brick chimney. Steam is supplied at 200 lb. pressure (14·1 kg. per square centimetre) and 100 deg. superheat, and the guaranteed water rates at various loads are as follows:—

Power factor 95 per cent.		Lb. Steam per kw. hour	
Per cent. load.	Kw.	28·5 in. Vacuum	29 in. Vacuum.
100	45,000	11·85	11·55
89	40,000	11·75	11·35
78	35,000	11·55	11·20
67	30,000	11·45	11·05
56	25,000	11·60	11·15
45	20,000	11·85	11·35
34	15,000	12·30	[illegible]

The condensing equipment is of the jet type. There are two No. 24 Westinghouse Le Blanc low-level condensers capable of handling 18,000,000 lb. (8,572,897 kg.) of injection water and of condensing 500,000 lb. (226,796 kg.) of steam per hour to 28 in. vacuum, with cooling water at 70 deg. [illegible] driven, through gears and can be operated separately if desired. The condensers are mounted below the turbine, and salt water from the Providence River is used [illegible] exhaust pipes, 42 in. (106·68 cm.) in diameter, lead from the high pressure side of the unit to outboard discharges, and two 42 in. [illegible] The steam supply for the turbine is taken by a 24 in. (60·96 cm.) steel pipe from a horizontal boiler-room main, the turbine line being [illegible] equipped with seven-retort Taylor stokers. There are six steel [illegible]

[illegible] 37 ft. (11·27 metres) wide and 18 ft. (5·48 metres) high. About [illegible]

[illegible]

Books Received.

[illegible]

* [illegible]

Elementary Principles of Continuous-Current Armature Winding.

By F. M. DENTON, A.C.G.I.

(*Continued from page* 851.)

Summary.—Continuous-current armature windings are first classified, the nature of the various classes of winding is then explained, and special terms used are defined. The derivation of the usual winding rules is developed by a simple method based upon an understanding of the ordinary Gramme ring. The rules derived apply to multiplex windings as well as to simplex. The use of multiplex windings is discussed, and reasons are given for the avoidance of their use. The simple theory of equalising connections is explained and rules are derived for the application of such connections. Chord winding is explained, followed by the use of interpolated commutator segments, and, finally, special consideration is given to the question of the number of slots that should be used for a given winding, taking into account the inductance of the parallel paths. The article concludes with a schedule of winding rules.

BRUSHES FOR WAVE WINDINGS.

Number and Position of the Brushes.—In deriving the various simplex and multiplex drum from the corresponding ring windings it has been understood that the commutator and its connections, together with the number and position of the brushes, remain exactly as for the ring windings. For the case of lap windings, whether simplex or multiplex, no further explanation is required. The case of wave windings is, however, a more difficult one. Referring to Fig. 17, we see that brushes placed at *A*, *B*, *C*, *D*, *E*, *F*, *G*, and *H* are all at one potential, and may be joined together. These bars are all idle as they move in zero field. Succeeding bars form tours lying all under S poles until the next zero point *W* is reached on the tour *P*, *Q*, *R*, *S*, *T*, *U*, *V* and *W*. Brushes may be placed at *P*, *Q*, *R*, *S*, *T*, *U*, *V* and *W*, and joined together. The brushes *A*, *B*, *C*, *D*, *E*, *F*, *G*, and *H* are at the beginning of a south polar series of tours, whilst the brushes *P*, *Q*, *R*, *S*, *T*, *U*, *V* and *W* are at the beginning of a north polar series. Hence if *A*, *B*, *C*, *D*, *E*, *F*, *G* and *H* are positive *P*, *Q*, *R*, *S*, *T*, *U*, *V* and *W* must be negative brushes.

FIG. 17.

FIG. 18.

FIG. 19.

Again, since the brushes *A*, *B*, *C*, *D*, &c., are all at one potential, the bars on which they lie being consecutive and [illegible] lying in the middle of interpolar spaces, the [illegible] of them will have no effect except to [illegible] at the remaining brush. The same applies to *P*, *Q*, *R*, [illegible] any number of brushes of like polarity [illegible] may be used on a wave winding.

[illegible] we would find that [illegible] and then up after [illegible] polar series of tours, whilst if it were duplex, the winding, instead of closing upon itself [illegible] to the first. [illegible] commutator [illegible] In general [illegible] just as [illegible]

[illegible]

thick enough to cover segments belonging to all the plexes, that is to say it should bridge m segments and should have a thickness of about $(m+1)$ segments. But when p sets of brushes are provided for a multiplex wave each brush need usually (that is to say, when m is not greater than $p/2$) be thick enough only to bridge one segment. This may readily be seen by referring, say to a four-pole duplex wave winding. Brush +1 touches a segment belonging to plex 1. At the end of the first tour, that is to say, after traversing four pole pitches, plex 1 will be four spaces ($2m$) or two commutator segments ahead of the beginning of the tour, or after traversing half a tour (two pole pitches) plex 1 will be one segment ahead of the axis of commutation. Thus brush +2 will just miss a segment of plex 1 and will touch one belonging to plex 2; That is to say, one of the positive brushes serves plex 1 and the other serves plex 2, and as these two positive brushes are joined together the effect is to parallel the two plexes just as a thick brush would have done. The same is true of the negative brushes. But the advantage of several thin brushes over one thick brush lies in the simplification of the mechanical problem of obtaining good and uniform contact at the brush faces.

It will be noted that the sum of the thicknesses of all the positive brushes must be at least equal to the thickness of the single positive brush which otherwise would have been used. And so, should a case occur in which the multiplicity m were greater than $p/2$, it would be necessary to use either a single positive brush bridging m segments or $p/2$ positive brushes bridging each not less than $m \div (p/2)$ segments.

A difficulty attending the use of multiple brushes on a wave winding.—An important practical difficulty attends the use of more than one pair of brushes on a wave winding. The cell diagram for a simplex wave having two positive and two negative brushes is shown in Fig. 18. The two brushes *a* and *b* are two low resistance paths in parallel and an increase in the contact resistance (and it should be noted that, with carbon brushes, reduction of current brings increase of resistance) of any one brush may almost entirely deprive this brush of current, thus causing the remaining brushes to become overloaded and to spark. Nor is there any automatic tendency to equalise the current distribution. On this account it is well in such cases to design the brush contact surfaces very liberally, making them capable of considerable overload.

Comparison of Figs. 19 and 20, the cell diagram for a four-

pole lap winding with Fig. 18, shows that in the case of lap windings there is an automatic tendency to re-adjust any inequality of current distribution. Should, for instance, brush a momentarily take less current than b, the armature re-action in path Aa would be reduced and so a greater E.M.F. would be available for the path Aa than for the other paths.

EQUALISING THE CURRENTS.

Equalising Connections.—In all types of windings having more than two parallel paths the paralleling of the paths is usually brought about by the brushes. In Fig. 21, for instance, of which Figs. 19 and 20 give the cell diagram, the four groups of cells are put in parallel by the brushes A,a, B,b, and should it happen that the brush contact resistances are not all alike, those sections having the best contacts will take an undue share of the load. Thus local heating will be set up in the armature and possibly sparking at the overloaded brushes.

Conductors called equalising connections are usually provided in lap-wound machines of ordinary speed and voltage having more than, say, 20 kw. output. These conductors are of copper and join permanently such pairs of points as E and F, G and H (Fig. 21) in the winding. If the resistance of these equalising connectors is small, inequality of distribution of the load between various sections of the winding due to changes in brush contact resistance will be effectually prevented, provided the resistances and the E.M.F.s of the sections are all equal.

carry no current, since they connect points which are always at equal potential. The choice of the number of such pairs of points that should be joined is determined by trial for machines of various design. It must be borne in mind that whilst, on the one hand, the use of many connectors of low resistance tends both to prevent sparking due to excessive loading of individual brushes and in the case of multipolar machines to allow large circulating currents to flow whose tendency is to produce an armature reaction which will weaken the poles that are too strong and strengthen those that are too weak, their use brings the disadvantage of considerable additional copper loss. The designer must be guided by practical experience; a rule which for many cases appears to be not unreasonable is to put equalising connections to every sixth to twelfth segment of the commutator (or at the corresponding point on the end connection at the back end of the winding), and to make the connector half as thick as an armature bar.

The current which flows in an equalising connector is alternating, and, on account of the inductance of the armature coils, lags considerably behind the E.M.F. generating it. Hence, just as in the case of an alternator upon inductive load, a small current produces great demagnetising effect upon the poles, and a marked advantage is obtained by the use of equalising connectors even when only a few are provided.

The provision of equalising connectors is so great an aid to sparkless commutation that it enables the designer to use shorter air-gaps and lower values of flux density in the teeth

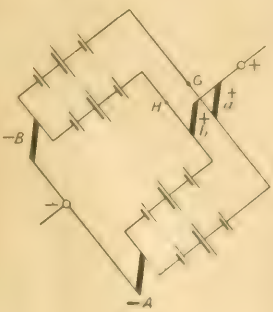

FIG. 20.

FIG. 21.

FIG. 22.

Or again, should for any reason (such as inequality of the polar air-gaps*) the E.M.F.s of the various parallel paths of the winding be unequal, circulating currents will be set up [illegible]

[illegible]

[illegible]

* [illegible]

than would otherwise be permissible, and so leads to higher efficiency.

In choosing pairs of points to be joined by equalising connections the condition to be fulfilled is that such points must [illegible]

[illegible]

(To be continued.)

Diathermy and Radiography.

The last meeting of the Institution of Electrical Engineers was held jointly with the Electrical Section of the Royal Society of Medicine. Two Papers, of which we give abstracts below, were read, and an interesting discussion took place.

Diathermy: The Use of the Electrical Current to Raise the Temperature of the Body in the Treatment of Disease.*

By E. P. CUMBERBATCH, B.M., M.R.C.P.

Heat is a valuable therapeutic agent, and it has been used in the treatment of disease for centuries.

[illegible] method heat is applied through the agency of an electric current passed through the body, part of the electrical energy being converted into heat as it overcomes the resistance of the tissues. Not only is the skin heated but also the underlying bones, muscles, and other parts. All other methods of applying heat raise the temperature of the skin only, because the latter is a very bad conductor of heat. The raising of the temperature of the tissues can modify their physiological processes, and exercise a therapeutic influence over them in cases of disease. Further, it is possible by means of the electrical current to raise their temperature to a degree sufficient to coagulate them and so destroy their vitality. The name "diathermy" signifies the "through and through" heating which the electrical current brings about, in contrast with the "surface" heating or "epithermy" produced by other methods.

[illegible] Diathermy.—If direct current is led through the skin by way of an electrode, 1 sq. in. in area, a stinging pain is [illegible] it reaches a strength of 10 milliamperes, and the [illegible] with a strength of 15 milliamperes. To heat the skin appreciably a strength of 400 milliamperes would be required. An alternating current of low frequency would be equally unsuitable to produce diathermy, because it would cause violent and intolerable contraction of the muscles before it attained a density sufficient to develop heat. The current alternates 5,000 times per second; the muscles contract only feebly and the stinging sensation is not felt. If the frequency of alternation is increased to 50,000 per second there is no perceptible stimulation of the tissues. At about 500,000 per second, the current will lose all power to stimulate the tissues whatever its strength or density, and no sensation will be felt other than that of heat. The limit of toleration of such a current is determined only by the degree of heat. Moreover, a high-frequency current will not produce the electrolytic changes in the skin and underlying tissues which a direct current, if applied with too great a density, is liable to bring about, with the formation of blisters and ulcers. The probable explanation is that the high-frequency current is unable to cause a migration of ions and the formation of new chemical compounds possessing caustic properties [illegible]

[illegible] of Diathermy.—To produce a degree [illegible] purposes, an apparatus that can [illegible] frequency [illegible] 100,000 times [illegible] [illegible] ting one. The condenser discharges across two [illegible]

a feeling of warmth will be evident, first in the wrists and then gradually spreading up the arms, pervading the whole body, and giving rise to the sensation of entering a hot-house. The temperature of the body may be raised from its normal value (98·4° F.) to 100°, 101°, 102°, 103° F. or even higher.

Application of the Diathermy Current to the Body.—If it is desired to raise the temperature of a part of the body a few degrees only, so that its vitality is not impaired, electrodes made of sheet metal are placed so as to include between them the part to be heated. They can be placed either in direct contact with the skin or with lint pads, soaked in strong salt solution, intervening. If the electrodes are not too small the density of the current passing between them will be low and the parts lying between them will be not unduly heated.

If, however, it is desired to raise the temperature of any abnormal tissue, such as a growth, to a degree sufficient to kill it, one of the electrodes is reduced to the size of a disc or button ⅛ in. to ¼ in. in diameter. The current density will be very great in the region of this small electrode and the heat will be sufficient to coagulate and destroy the tissue.

Two examples of the uses to which diathermy has been put will be given. A painful form of inflammation of the knee is caused by the micro-organism known as the gonococcus, which thrives at the temperature of the body, but is very sensitive to a hotter surrounding, and can be killed if the temperature is raised a few degrees. The knee joint can be heated through and through by the diathermy current and the organism killed.

Diathermy is a valuable method of treatment of cancer and other malignant growths. It raises their temperature till they are coagulated and destroyed in situ. The application of hot cautery instruments to the growth would simply burn the parts where contact was made and the destruction would spread scarcely any distance below, because the tissue is a very bad conductor of heat. The tissue conducts the diathermy current, however, so that it is heated through and through and coagulated en masse.

Single-Impulse Radiography (Instantaneous): Its Limitations and Possibilities.*

By ROBERT KNOX, M.D.

In the initial stages of radiography, radiograms were obtained by time exposures of considerable duration amounting to an hour or more.

The first serious attempt to produce apparatus facilitating single-impulse exposure was made by Klingelfuss, who in 1901, by means of a "break" voltage due to a sudden interruption of the primary current of an induction coil, produced a brilliant illumination in an X-ray tube. The exposure time was a fraction of a second.

Drs. Albers Schönberg and Walter carried out experiments on similar lines. A 7 in. parallel spark was about the maximum obtained. With an exposure of roughly about 1/200th of a second, it was possible to obtain radiographs of the thorax and other parts of similar thickness, but not of the abdomen.

Koch in 1907 endeavoured to obtain a single-flash interruption through breaking a copper wire in the primary circuit of the coil by means of a pistol shot, and Dessauer developed this process. He also introduced a system for breaking the primary current by causing a thin wire enclosed in a cartridge to melt rapidly by an overload of current. It is claimed that a current of 200 milliamperes was obtained for a spark-gap of 16 in., or about 150 milliamperes through a soft tube, that is, one suitable for thorax exposures.

A further development of the method led to the production of the [illegible] impulse process. This is based upon the utilisation of the impulse which is generated in the secondary windings of the coil [illegible] the primary current is suddenly commutated, in such a way that double the effect due to the "break" voltage is obtained. A specially designed "single impulse" switch is provided which the author describes in the original Paper.

Originally an induction coil was used in connection with this form of single impulse apparatus, but a transformer with a closed magnetic circuit is more suitable, and a combined apparatus has been constructed in conjunction with a high-tension rectifier, using the transformer in conjunction with this apparatus for ordinary work and the single-impulse apparatus for its special purpose. This apparatus is capable of dealing with all work necessary in X ray technique, i.e., X ray therapy, as well as radioscopy and radiography.

The combined apparatus can be connected to a direct-current supply, and further developments have made it possible to construct an apparatus which can be connected to single phase or three phase alternating current. Shorter exposures are claimed than 1/100th

* [illegible] Institution of Electrical Engineers.

* Abstract of a Paper read before the Institution of Electrical Engineers.

of a second, but for practical purposes it may be assumed that the average length of a single flash is in this neighbourhood.

I have two different types of single-impulse apparatus under my care: (*a*) with a mercury dip interrupter and (*b*) a Siemens single-flash coil outfit. To ascertain the radiographic efficiency of these sets of apparatus an extensive set of experiments was carried out, bearing on (1) the best conditions for working, (2) the testing of the uniformity of the discharge over a large number of exposures, and (3) the value of intensifier screens for use with single-flash exposures. The apparatus was used with two forms of X-ray tubes, namely, (*a*) the gas tube, Macalister Wiggin tungsten target, and (*b*) the Coolidge tube.

The Coolidge tube is by far the best and most reliable tube to use for this class of work because of its great flexibility, its durability, and the great ease of manipulation which it allows. With one tube any number of exposures may be made with the tube emitting rays of varying penetration, and the discharge is remarkably uniform.

It would be a great help in technique if the intensifier screen could be dispensed with altogether; at present this cannot be done because the apparatus is not powerful enough. In all the exposures made at a distance of 1 ft., without an intensifier screen between the surface of the plate and the anticathode of the tube, the exposure is nearly a full one. But it would be desirable to have to work at distances up to 6 ft., in heart work especially. I leave it to the electrical engineer to calculate the size and the capacity of an apparatus capable of dealing efficiently with the thorax of a 16-stone man at a distance of 6 ft. between the anticathode of the tube and the surface of the plate. Moreover, in the near future apparatus may be required which will penetrate and give a photographic record of a piece of metal 3 or 4 in. in thickness. The single-impulse apparatus of the present day is not capable of dealing with this proposition. The greatest spark length obtained from a single-impulse exposure through a Coolidge tube was about 12 in.

In the original Paper the author describes some further experiments illustrating the effect of passing the rays through the screen on to the film, and the gain in sharpness of the detail when the screen is not used; also the value of being able to work at greater distances than 1 to 2 ft. For all distances under 6 ft. a certain amount of distortion is produced.

The great advantage over work which is now carried out by time exposures will be that there will be no plates spoiled by movement on the part of the patient. With a single-impulse machine we can allow a child to be upon the plate and move about—the exposure is made while the child is actually on the move—yet the picture obtained shows no trace of movement. While up to the present the uses of the single-impulse exposure have been practically confined to the examination of the thoracic and abdominal organs with the intensifying screen, there are possibilities for its use without the latter, *e.g.*, examination of the bones and joints of children where [illegible]

[illegible]

[illegible]

The primary current could be arranged for by placing the regulator on the same stud of the resistance; the heating current would also correspond. The distance between the anticathode and the plate would be constant.

A table could be produced which would state definitely the conditions necessary for a particular part; if all the factors corresponded and the apparatus worked accurately, then it should be possible to turn out standard results with a fair degree of accuracy.

These results are all within our reach when we have the apparatus capable of giving a much larger output than those at present in use.

DISCUSSION.

Dr. METCALFE said he had noticed the advantage of the form of radiography described by Dr. Knox a considerable time ago. [illegible] months before the war he had obtained an apparatus of the [illegible] type similar to that shown by Dr. Knox on the screen, and he had purchased the apparatus largely on the advice of Mr. [illegible]. With the limitations mentioned by Dr. Knox, he had been extremely pleased with the mechanism. [illegible] it had been a most successful apparatus. Although he had had it between four and five years it had required no repair whatever, and he had never even greased it. As Dr. Knox had said, the apparatus undoubtedly had great limitations. Its great advantage was in the examination of the heart. The heart, of course, was never still; it was always in movement, and consequently, to get a very sharp and definite contour of the heart, it was necessary to have an absolutely instantaneous apparatus. And by the single-impulse method of radiography he hoped and thought it would be possible in time to come, not only to make [illegible] pictures of the heart, but to form a definite system of diagnosis of heart disease from a series of pictures of this character. Even now it was possible to make excellent heart pictures, having, as Dr. Knox had shown, very definite outlines, and if one studied those outlines very carefully one could read into those heart pictures a great many of the appearances which would result from the clinical observation of disease. So that for the heart this was undoubtedly the best method of examination. The question of the screen was, of course, an annoying one. Good pictures could not be made by a single-impulse method without an intensifying screen, and to get a good picture at a considerable distance—say 6 ft.—more E.M.F., probably, was required than could be obtained by the single-impulse method; and in that case two intensifying screens would, he thought, be necessary. He had lately been doing some work with the Austin Edwards film, which was made of collodium with a coating of emulsion on each side, and if two intensifying screens were used intensification was obtained on both sides, resulting in a very much stronger picture than was the case where only one screen was employed. Some of the intensifying screens were rather thick and rather rigid, and did not seem to come into very close apposition; consequently there were very often blurring and shadows of a rather peculiar character, which certainly militated against the picture as a picture. Such defects did not, perhaps, interfere with the diagnosis; but, after all, every radiographer liked to be able to present a good picture from the aesthetic or artistic point of view, and this was sometimes not possible when films and double intensifying screens were used. But to his mind it was not necessary to do bones—arms, legs and so on—by single-impulse radiography. By the use of instantaneous radiography, with an exposure of a fraction of a second, or even of a second, a wealth of detail was obtainable in regard to bones that could not, in his opinion, be surpassed by any method of single-impulse radiography. The difficulty was, as Dr. Knox had said, that it was necessary to bring the tube so close to the patient that it became sometimes almost dangerous to use it, and the patient did not like it. Moreover, the field of vision was limited. Of course, the putting in of the intensifying screen and the taking it out again, and the having to go into the dark room and so on, was a great nuisance; it took up a great deal of time, and it was unpleasant to have to do it. Undoubtedly what was wanted, and what would no doubt be evolved in the future, was a machine without these limitations.

Dr. WORRALL said the subject of Dr. Cumberbatch's Paper was one which was in its infancy, and with which no one could as yet claim any great acquaintance, either in its physical or its medical aspect. As Dr. Cumberbatch had said, heat was a valuable therapeutic agent, and had been used in the treatment of disease for centuries. If the part of the body sought to be treated was [illegible] from the surface, the heat could only reach it (1) by conduction through the tissues, which (and [illegible]

[illegible]

Mr. [illegible] thought the author had done a great service in bringing forward that Paper. [illegible]

[illegible]

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The Position of Single-Phase Distribution.

The problem of supplying outlying districts and small towns, or large villages, where the density of the demand is by no means great, has always been a difficulty to engineers responsible for dealing with electricity supply. In the case of small towns, continuous current offers certain distinct advantages, and it has therefore been very frequently adopted. In due time, as these small towns grow in importance and become more extensive, a simple continuous-current system often fails to meet the required conditions; the radius of distribution may become too great, and then it is that consideration must be given to the laying down of a station for three-phase generation and distribution, continuous current being possibly retained for the existing network.

Moreover, there is another possibility which is becoming increasingly marked as progress is made. This is due to the fact that bulk supply becomes more and more worth consideration on the part of the engineer of the small undertaking. If a bulk supply is desirable for a continuous-current station, what alterations are to be made? The line of least resistance is to replace the prime movers by electric motors and to supplement these as time goes on by rotary converters. This leaves the permanent disadvantage of rotary plant, which would otherwise be unnecessary. The problem is, of course, much simpler if continuous current has not been adopted in the first instance. If single phase distribution has been utilised, then a supply can be taken from a three-phase transmission of the same frequency, and may be utilised with very little difficulty to supply single-phase current, the district being divided up so as to give a reasonably balanced demand on the three phases.

A similar problem often arises in connection with the extension of a supply to outlying districts. Assuming that the central part of the area is supplied with three phase current, then the simplest form of extension is by giving single-phase supply in such districts as may not warrant the outlay on three-phase mains.

The great objection to the adoption of single phase, apart from the fact that three phase current is cheaper in generation, is that the single phase induction motor can bear no comparison with the corresponding three phase machine. It gives a poor starting torque, and has always been looked upon as the weakest part of the single phase system from the power point of view. The difficulty in so far as electric traction is concerned has been surmounted, as is well known, by the development of the commutator single phase motor. In our present issue we give a Paper by Mr. F. Creedy advocating the claims of the commutator machine for single phase power work generally. We have not had an opportunity of verifying the claims made by Mr. Creedy on behalf of the motor with which he is identified, but we think it will be agreed that he makes out a very good case for the [illegible] of this motor in its present state of development. In comparison with other types, such as the continuous-current motor and the polyphase motor, whether slip-ring or squirrel-cage, it must be admitted that the single phase compensated commutator motor is considerably more expensive. It is necessarily even more expensive than the ordinary single-phase induction motor, but it presents the very great advantages of high power factor, good torque, low starting current and variable speed, and it will be admitted that it is worth while to pay something for this combination of virtues. The question of power factor alone is by no means unimportant, but it is rather on three phase than on single networks that trouble is to be anticipated from this cause, for, where there is a large power load, the three-phase system is almost certain to be employed. In any case, however, high power factor is very acceptable. Simplicity in starting gear is also a desideratum, and for comparative purposes the starter should be included in the price of the motor.

We do not suppose that engineers will feel disposed to say that single-phase distribution can in general be held up as a competitor against three-phase, but it is none the less a fact that in many cases where the power load is not considerable single-phase distribution presents great advantages from the point of view of simplicity. If then the one objection—namely, the weakness of the single-phase motor—can be removed, there is no reason why single-phase distribution in its proper field should not be used to a greater extent and to considerable advantage.

Reviews.

Electrical Measurements. By Frank A. Laws. (London: Hill Publishing Co.) Pp. xiii.+719. 21s. net.

This is an admirable book, and is strongly recommended to the electrical engineer and the physicist desirous of obtaining a sound knowledge of the more important electrical measurements. The work gives the impression that Prof. Laws is a good teacher, for he has evidently not only convinced himself of the soundness of the methods he describes, but he well directs his efforts to convince his readers also. The book, however, is not a mere compendium of methods; the mathematical basis of the measurements receives careful treatment, and it is all so good that it is a pleasure to record that none of it has been put in small type for the reader to skip. But it is not an elementary text book, and readers are expected to be familiar with all kinds of electrical circuits and to have a fair knowledge of the calculus.

Commencing with the measurement of current, various forms of galvanometers and ammeters are described and their particular faults and virtues pointed out. The equation of motion is made use of at an early stage, and the advantages of a non-oscillatory deflection are shown in a very satisfactory and convincing manner. Succeeding chapters deal with resistance measurements and devices, the measurement of potential difference and electromotive force, power measurement, measurement of inductance and capacity, electricity meters, phase meters, curve drawing instruments, transformers, the calibration of instruments, the determination of wave form, and cable testing. In dealing with these subjects the author does justice to both European and American methods, and the numerous references to literature pertaining to the methods will be found most useful to the physicist engaged in research.

In the space available, the refinements necessary for very accurate work have perforce been omitted, but the section on calibration of instruments should serve to impress on the observer that mere agreement of results is no indication that the quantity under measurement has been accurately determined. The determination of what degree of accuracy shall be required is largely an economic problem, owing to the increase of labour as the required degree of accuracy is raised, but a knowledge of the general sources of error in instruments is important for all classes of measurements, and should be possessed by all observers.

In the section dealing with resistance measurements there

is a good description of the Kohlrausch method of using the differential galvanometer. This I believe is by far the best description so far in English. Although this method is the only possible way of employing a differential galvanometer for precise work, it may be noted here that its use is on the decline, even in Germany, as better methods are now known for such measurements as it was primarily intended for. The measurement of resistances with potential leads by means of the Wheatstone bridge might be included with advantage; the Kelvin double bridge method is now fairly well known, but it is not sufficiently realised that the Wheatstone bridge can be used for precise measurements of comparatively low resistances with potential leads.

Methods for the measurement of inductance and capacity have been very closely studied during recent years, but the Papers dealing with them are widely scattered and are not readily available to the electrical engineer and physicist. Prof. Laws has summarised the position in an admirable manner, and includes in his text an excellent description of the older tried methods, together with those of quite recent date. Inductance formulæ are not proved: the good work of Rosa and Grover at the Bureau of Standards makes this unnecessary. I find that the Helmholtz speed regulator is wrongly credited to Giebe; it was Helmholtz who suggested the device and Giebe who developed it. A noteworthy omission occurs in the oscillograph section. In general the author's selection of instruments and methods is so good that one feels convinced there was an oversight in not including Irwin's hot-wire oscillograph. A description of this novel and instructive instrument should appear in the second edition of the book, which surely will be wanted at an early date.

Altogether, Prof. Laws' book is a valuable contribution to the subject of electrical measurements. F. E. SMITH.

Correction Tables for Thermodynamic Efficiency. By C. H. NAYLOR, A.M.Inst.C.E. (London: Edward Arnold.) Pp. 59. 5s. net.

This volume contains 27 tables, each of which covers a double page. Each table gives a multiplying factor which the author terms a Correction Factor, the object of which is to alter the thermodynamic efficiency of a turbine tested or considered under certain specified conditions of pressure, initial superheat and low pressure in order to obtain a thermo-dynamic efficiency at standard conditions. The standard conditions adopted are, for high pressure turbines, 180 lb. gauge pressure, [illegible] F. superheat measured at the stop valve, and 28 in. vacuum (barometer 30 in.), and for low pressure turbines, dry saturated steam at 16 lb. per sq. in. absolute pressure and vacuum 28 in. The tables give the correction factors for a series of pressures ranging from [illegible] down to 50 lb. per sq. in. and for 12 different amounts of superheat. Each of these series is worked out for low pressures which vary from 27 vacuum to the extremely low figure of 29·1. The volume is published for the Turbine Section, the British Electrical and Allied Manufacturers' Association, and although it will appeal to a small section of the engineering profession, to them it will prove of very great value. A. J. M.

Heat Drop Tables: Absolute Pressures. Calculated by H. Moss, M.Sc. (London: Edward Arnold & Co.) Pp. 64. [illegible] net.

This volume is uniform in cloth and size with the recently published "Callendar Steam Tables," issued by Messrs. Arnold & Co. It is now generally accepted that the characteristic equation formulated by Prof. H. L. Callendar constitutes the only consistent system for evaluating the fundamental properties of steam.

In the past, when dealing with [illegible] of turbines and reciprocating engines, [illegible] of heat quantities were relatively unimportant; but in the present [illegible] efficiency [illegible] with a large range of temperatures it is an essential that we should know the total and latent heat of steam at very low pressures with as close an accuracy as possible. Prof. Callendar's researches have enabled Mr. Moss to produce this volume, which contains a series of some [illegible] tables, each of which occupies a double page. Every table gives the heat drop from an upper pressure to a standard low pressure. For each table there are 36 different high pressures, and for each of these there are columns for 12 different amounts of initial superheat. The low pressures vary by stages of 0·1 from a vacuum of 27·0 to one of 29·1. Mr. Moss has worked out over 12,000 numbers, and turbine designers owe him thanks for his labours.

Every laboratory of steam engineering, and places where steam turbines are designed or run, should have a copy of these tables handy for ready reference. A. J. M.

Mechanical Handling of Material and Its National Importance During the War. By G. F. ZIMMER, A.M.I.C.E. (London: Crosby, Lockwood & Son.) Pp. 135. 10s. 6d. net.

Certainly, among the other lessons we are learning in this war, the importance of mechanical handling of materials takes a prominent place. In this work, reprinted from "Cassier's Engineering Monthly," Mr. Zimmer touches a problem of great topical interest.

After dealing with pneumatic handling and ash-hoists, the author devotes a dozen pages to the storage of coal, and then passes on to conveyers and elevators. Telphers and mechanical stokers are dealt with in some detail.

Under the head of floating load devices the coaling of ships, both stationary and under way, is described, the account of oil-fuel bunkering at sea being of special interest. The section on portable loading and unloading devices is fully illustrated, a variety of modern endless chain devices, band conveyers, and bulk loaders for handling sand, coal, crushed stone, &c., being shown. Locomotive coaling stations also receive attention, a somewhat striking illustration of the station of the T. W. Snow Construction Co., of Chicago, being presented.

The greater part of the work is devoted to descriptive matter, the author's aim being to give a general view of modern handling machinery, and the liberal use of illustrations conduces to this object. In his concluding remarks he mentions one or two striking facts. In mines the average tonnage per man per day is about 2–2½ tons for handwork; whereas by the aid of mechanical cutters and coal face conveyers, the corresponding figure is about 3–3½. Another field where conveying machinery has a great scope is in the steel industry, where the future rests with the country that can produce most cheaply, and where mechanical handling is one of the greatest aids to economical production.

Year-Book of the Carnegie Endowment for International Peace, 1917. (Washington: Headquarters of the Endowment.) Pp. [illegible]

This year-book appears at a time when the aims of the promoters of the endowment seem unfortunately far removed from realisation. Yet there is much in it which deserves special study in the present circumstances. The book contains an account of the organisation of the endowment, reports of the secretary and executive committee, and sections devoted respectively to intercourse and education, economics and history and international law.

With the general aim of international peace all must sympathise. A great deal of work has been done in the direction of reprinting and translating works dealing with international agreement in various forms, and it may be that ultimately the ideas thus fostered may assist the creation of international machinery for the preservation of peace and pave the way for future practical action. The director of the Division of Intercourse and Education, in concluding his report, suggests that a crisis in the present war has been reached, with the inference that the conclusion is less distant than at present appears. Let us hope that his expectations may be justified.

Gravitation: Discovery of its Cause and Mechanism. By [illegible]

In this pamphlet the author claims to explain the mechanism of gravity. [illegible]

the central masses. These ethers are then expanded and discharged. The effect of the absorption of these ethers being to draw the earth's crust towards the heated masses, thereby producing gravity. We fear that the author is very far from producing an acceptable theory.

Directions for Designing, Making and Operating High Pressure Transformers. By Prof. F. E. AUSTIN. 2nd Edition. (London: E. and F. N. Spon.) Pp. 46. 3s. net.

A second edition of this little book has now come to hand. The subject is compressed into a very small space, and the book is thus evidently not intended for those who wish to dip into the subject to any serious extent. Nevertheless, condensed treatment of this kind may be of value to a certain class of reader. We referred to the first edition as recently as 1916, so that we need not say more on the present occasion.

Science in Education.

A report has been issued by the Committee appointed in August, 1916, to inquire into the position of natural science in the educational system of Great Britain, especially in secondary schools and universities.

In its general conclusions the report (which contains 86 pages) recommends that natural science should be included in the general course of education for all up to the age of about 16, and that the tests of such a course, as recommended in the report, should, with necessary modifications, be accepted as the normal qualification for entrance to the universities and professions. A large increase in the number of scholarships at all stages of education is held to be necessary, and periodical inspection, under the direction of the State, should be compulsory on all schools.

In regard to secondary schools, steps should be taken to secure for all pupils in State-aided secondary schools a school life beginning not later than 12 and extending at least to 16, and the general course of education, including science, for all pupils in public and other secondary schools up to about that age should be followed by more specialised study, whether in science or other subjects. In all secondary schools for boys the time given to science should be not less than four periods in the first year of the course and not less than six periods in the three succeeding years. A larger number of State-aided schools should be encouraged to provide advanced instruction in science, and those which do so should be staffed on a more generous scale. For pupils under 16 the science work should be planned as a self-contained course, including, besides physics and chemistry, some study of plant and animal life. There should be as close correlation as possible between the teaching of mathematics and science [illegible] natural science, and in it there should be co-operation between the [illegible]

[illegible]

UNIVERSITY EDUCATION.

The universities should adopt the First School Examination as the normal examination for admission, abolishing special matriculation examinations for candidates from schools. The normal age of entry into the universities from secondary schools should be 18, which should also be the age limit for entrance scholarships at Oxford and Cambridge. Special arrangements should be made to test the fitness for entrance into the universities of candidates over 23 years of age. Oxford and Cambridge should provide more suitable courses in science for those who do not aim at an honours degree.

A large expenditure of public money is regarded as necessary to equip the universities for their work in pure and in applied science, and grants to them from public funds should be increased to allow them to make a substantial reduction in their fees. Even now, it is held, there is need for larger expenditure on scholarships, and the need will become greater as the waste of talent due to imperfections in the present system of education is diminished. But scholarships should be definitely associated with the idea of distinction conferred in recognition of intellectual merit and promise, and should be of a nominal value (say, £20), to be supplemented if and so far as scholars require further assistance, to the extent where necessary of defraying the whole cost of their education and maintenance.

SCIENTIFIC WORKERS.

The last portion of the report deals with the supply of trained scientific workers of all grades for industrial and other purposes, which is described as a matter of the utmost gravity and urgency, since for the prosperity and safety of the country after the war the development of the resources of the Empire and the production of our industries must be on a scale greatly in excess of anything we have hitherto achieved. A number of reforms are outlined which must be effected if the supply of scientific workers is to be increased. If science is to come by its own the nation as a whole must be brought to recognise the fundamental importance of the facts and principles of science to the right ordering of our national life. The requisite training and opportunities must be provided for those capable of advancing natural knowledge or acting as scientific experts, but it is no less important to secure for all who are of an age to receive it an education that will enable them to realise the vital need of a knowledge of science for both the individual and the national well-being.

The report is signed by all the members of the Committee, except Dr. M. E. Sadler, whose duties as chairman of the Calcutta University Commission prevented him from attending the meetings after Sept. 30, 1917.

Correspondence.

ELECTRICITY AND GAS RESTRICTION ORDER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: May one express the hope that your influential columns will be opened to protest against the above very undigested proposals.

A writer in "The Times" of yesterday's date shows how the Order as at present in force gives a premium to those who have been most wasteful in the past, but there are many other points of equal importance which should be pressed on the notice of the authorities.

At the present time it is almost, if not quite, impossible to obtain lamps of the lower candle-powers in less than six months, my own experience being that some 10-watt lamps ordered in November were delivered last week.

As regards heating, &c., by gas and electricity, many people went to considerable expense last autumn, when the Government made the appeal for a reduction in the use of *raw* coal, and installed gas and electric apparatus, and by that means reduced their *raw* coal consumption far below the allowable limits of the Coal Order, and the immediate result of this new Order will be to increase the tendency to revert to coal, thereby increasing labour requirements in every direction. All coal that is used in domestic fires has to be handled at least twice before it reaches the consumer, whereas that dealt with at gas and electricity stations is often handled only once in all from the pit mouth, thereby reducing waste to a minimum.

No attempt has been made in this latest Order to maintain the doctrine of equality of sacrifice, which is working well as regards our food supplies; and the same defect was apparent in the Coal Order of last autumn, so that instances can be found with very little trouble, such as the following:—

(A) Fourteen room house, five persons, allowed more coal than—

(B) Twelve room house, eight persons, including three small children.

Another instance even more glaring is—

(C) Small house, weekly rent 8s. 6d., where coal is bought in 1 cwt. lots, has actually used more coal during the past six months than either (A) or (B) are allowed, while the small house in question only has three persons living in it.

These Orders appear to have been conceived in the same way as the absurd railway lighting restriction of the first two winters, whereby the eyesight of those foolish enough to try and read in the trains was seriously injured in many cases, while the glare from the fire boxes of the engines was visible over an area 10 times as wide as the carriage lighting would cover.

This morning, for instance, shows the absurdity of the whole proceeding, for Sir Albert Stanley has not, with all his Orders, been able to prevent a fog, which has necessitated the use of artificial light throughout the London area, which has probably at one blow wiped out the entire possible saving for the quarter in lighting under the Daylight Saving Order.

No one will complain if restrictions are based on legitimate lines, with equal sacrifices for all; but to issue haphazard Orders with obviously not the slightest regard for the ordinary phenomena of Nature is simply silly.

This morning's experience makes one wonder whether Sir Albert will be more successful in providing a warm winter for 1918-19 with fewer dark days, for it is obvious that people cannot work if they are very cold, neither can they work in the dark.

For obvious reasons I beg to sign under a *nom de plume*.

I am, &c.,

London, April 3. ENGINEER.

[We agree with our correspondent that the new Order introduces many difficulties, particularly for those who have already economised. The reference to daylight saving, however, is not to the point, as the saving due to this is quite irrespective of fog; in other words, the effect of a fog is felt whether there is daylight saving or not.—ED. *E.*]

ELECTRIC POWER SUPPLY AND COAL CONSERVATION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR,—With reference to your account of the meeting at the Engineers' Club, Manchester, as contained in your issue of April 12th, I should like to comment on the wording of your article where, by condensation, I think the meaning of some of my remarks has been changed in sense. [illegible]

I am, &c.,

Sheffield, April 16. W. M. [illegible]

"Mazdalux" Metal Reflectors.

[illegible]

This illustration is useful as showing the very large size that some of these Reflectors have to be made to accommodate the largest half-watt or gas-filled lamps.

Four pages of this list are filled with data for customers' use in planning lighting installations, such as tables, [illegible] and instructions to facilitate illumination calculations and the preparation of lighting schemes.

PHOTOGRAPH OF MAZDALUX METAL REFLECTOR [illegible] HALF WATT TYPE LAMPS.

The [illegible] issued by H.M. Stationery Office, entitled "The Lighting [illegible] [illegible]

Copies of this useful list can be obtained on application to the Publication Department [illegible] Mazda House, 77, Upper Thames-street, London, E.C. 4.

A New Bolt Switch.

[illegible]

[illegible]

[illegible]

Beads for Insulation.

Those who have had to use glass beads for insulating bare wire interconnections in various apparatus, such as electrical heating and cooking gear, controllers, resistances, &c., must at times have regarded this method as a necessary evil; chiefly owing to the fact that it was impossible to bend a connection without exposing the wire. Crossing leads so "insulated" was attended with serious risk of short circuit.

Fortunately the objections to using glass beads have now been overcome by the introduction of Fish Spine Beads—which when threaded on the conductor, enable it to be bent at a sharp angle without any chance of the wire becoming exposed. They are made in a vitreous heat-resisting material, which will permit the connections running up to bright red heat without damage to the beads. The Admiralty, after testing the beads, have adopted them for use in connection with Admiralty electrical gear.

These Fish Spine Beads are manufactured by Taylor, Tunnicliff & Co., Ltd., 110, Cannon-street, London, E.C. 4, who are well known in connection with insulator manufacture. The beads are an all English production and are produced in six sizes to take up to 10 S.W.G.

Legal Intelligence.

Mr. Ferranti's Spinning Invention.

Last week Mr. Justice Sargant heard a petition by Mr. Sebastian Z. de Ferranti and Messrs. J. & P. Coats (Ltd.), for an extension of a patent granted in 1903 to Mr. Ferranti. The patent was for an invention relating to "spinning, twisting and doubling machinery," and it was said that before making his invention Mr. Ferranti removed his business to the centre of the cotton industry, and addressed himself to the problem of increasing the speed at which spinning could be carried on, and after several years of experiment and research he found out reasons why it had been hitherto impossible to spin at speeds higher than 10,000 revolutions a minute. His invention consisted in an entire alteration of the existing type of spinning machinery, and the substitution for the band driving of the spindles of an independent driving of each spindle by a motor attached thereto. He claimed that the speed attained was 20,000 revolutions a minute.

Mr. WALTER, K.C., on behalf of the petitioners, stated that the company which was entitled to Mr. Ferranti's patents, and of which he was managing director, got into financial difficulties: but Mr. Ferranti got backed his patents for £5,000, found for him by his friends. Then he took the patent to Messrs. Coats, who were so impressed with the value of the invention that they found the £5,000 and gave him a further sum for experimental work and development. Altogether they had spent £40,000, not in altering any of the essential features, but in making the invention foolproof. Messrs. Coats had an exclusive licence for making and using the machine for thread, and the rest of the patent belonged to Mr. Ferranti. Messrs. Coats had sufficient means to introduce the [illegible], and desired the Court to grant them an [illegible] of the patent. There were no opponents of the petition.

Mr. [illegible] and Mr. Ferranti gave evidence.

His Lordship [illegible] judgment, and he was inclined to grant [illegible] had not been for the difficulties [illegible] extension. He suggested that the inventor and Messrs. Coats might take each 50 per cent. of [illegible] £20,000 that had to come [illegible]

Parliamentary Intelligence.

SHROPSHIRE, WORCESTERSHIRE, AND STAFFORDSHIRE ELECTRIC POWER BILL.

[illegible]

unable to meet. The promoters were asking for compulsory powers to acquire a site on the river Severn, just outside Stourport, for the erection of a generating station for the purpose of manufacturing gas used in the generation of electricity, for the purpose of dealing with residuals resulting from gas manufacture, and for putting up plant for electro-chemical processes which had not hitherto been established in this country. He asked their Lordships to say that the general convenience of the public must override the question of individual comfort, and that the company was not to be liable to indictment for creating an unpreventable nuisance. The promoters had agreed to amend clause 26, which gave them power to enter into agreements with any authorised distribution. All they now asked for was for power to link up with the Kidderminster and the Hales Owen Electric Traction Companies and Birmingham Corporation.

Mr. W. L. MADGEN, chairman of the company, said that since he became chairman of the company in 1908 the capital expenditure had increased from £35,809 to £710,217, and the revenue from £10,425 to £70,108. The Ministry of Munitions had placed at the disposal of the company a sum of £200,000 in view of the importance of factories in the area. He did not anticipate any considerable falling off in the demand for electricity after the conclusion of peace, because electric power was essential to the economical carrying on of every industry in the country. He had proposed to put up at the new generating station a plant of 80,000 kw., with 20,000 kw. as a stand by. The existing generating station was not designed to supply electricity on the scale now demanded; the site was not adapted for the production of power on a large scale. The site at Stourport would obviate all difficulties. A largely increased supply of electric power was urgently needed in the area, and it was essential that a new site should be provided for the generating station; in the whole area there was not a site comparable with that selected. It was proposed to put down plant for extracting nitrogenous products from the atmosphere.

In cross-examination by Mr. TALBOT, witness admitted that at present the company's area of supply was confined to a small district in the neighbourhood of Birmingham. The total capacity of the present station was about 35,000 kw.

On Tuesday evidence in favour of the Bill was given by Mr. GEO. BEAN, Mr. CHAS. P. SPARKS and Mr. ARNOLD B. GRIDLEY.

The proceedings had not concluded when we went to press.

Yorkshire Electric Power Bill.—The Board of Trade have reported on this Bill, and, without expressing any opinion on the merits of the questions raised by it, they suggest that, pending any action that may be taken as a result of the report of the Coal Conservation Sub-Committee of the Reconstruction Committee and of that of the Electric Power Supply Committee, it is inexpedient that the powers sought by clause 3 of the Bill should be conferred on the Yorkshire Electric Power Co. The company has therefore decided not to proceed with the clause.

The Gas and Electricity Order.—In the House of Commons last week Sir A. Stanley stated that a consumer might take as the basis of his calculation his consumption of gas or electricity for the corresponding quarter of either 1916 or 1917.

Before proceedings could be taken for infringement of the requirements of the Order, the Board of Trade must call upon the consumer for an explanation of the apparent excessive consumption, and must consider such explanation. Where an explanation is found satisfactory no proceedings will be taken.

In connection with the above, the Suffolk Electricity Co., of Stowmarket, has issued a circular which will be of assistance to their customers in complying with the Order. It asks them to see that their lamps and motors are the most efficient, and to apply to the company for free advice how to economise. It is pointed out that "considerable saving in coal can be effected by using electricity for cooking. This company will give what assistance they can to expedite the installation of electric cooking apparatus.

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES VOLUNTEER ENGINEERS.

Headquarters: Balderton-street, Grosvenor-square, W. 1.

Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.

Orders for the Week.

Officer for the Week.—Capt. W. Hynum.

Next for Duty.—Capt. W. Darley Bentley.

Monday, April 22.—No. 3 Company, 6.30–8.30. Recruits' Drill, 6.30–8.30. Signalling Section, 6.30–8.30.

Tuesday, April 23.—Lecture on Demolitions at 6.30. Physical Drill and Bayonet Fighting, 7.30.

Wednesday, April 24.—No. 1 Company, Drill, Knotting, &c., 6.30–8.30. Recruits' Drill, 6.30.

Thursday, April 25.—No. 2 Company, Drill, Knotting, &c., 6.0–8.0. Recruits' Drill, 6.30–8.30. Signalling Section, 6.30–8.30. Ambulance Section, 6.30–8.30.

Friday, April 26.—Musketry, 5.30–8.0.

Saturday, April 27.—Entrenchments, &c., for the whole Corps, 2.45–4.45. Recruits' Drill, 2.45–4.45.

Sunday, April 28.—Commandant's Parade at Waterloo Station, 8.45, for work at Esher. Marching order with rifles. Mid-day and tea ration to be carried.

Special Notices.—All drills will take place at headquarters unless otherwise stated.

The medical officer will attend for the medical examination of recruits on Thursday evening at 6.0.

Recruits will attend for Engineering Instruction with the Companies.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Pryor, Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1917 Specifications.

264 [illegible]

1,729 Waterhouse, L. M. System of the apparatus for wiring ships, buildings, and the like for the distribution of electricity. (3,2 17.) 113,800.

1,7[illegible] [illegible] for use in ignition systems. (3,2/17.) 113,802.

[illegible]

3,318 Brown, Boveri & Co. & Gray, A. Control and regulation of electric furnaces (6,3/17.) 113,827.

Consists in a method of controlling an electric furnace by automatic variation of the length of the arc, according to which a motor and generator combination is so arranged that the power supplied to the motor is proportional to the variation in the predetermined current input of the furnace.

3,425 Insull, M. J. Electrical contacts. (8 3 17.) 113,838.

[illegible]

3 551 Young, A. Apparatus for the purpose of the direct conversion of the energy of motion of a dielectric into electric energy; and conversely for the conversion of electric energy (of the right frequency) into the motion of mass. (10/3 17.) [illegible]

3,748 Duggan, J. Overhead equipment of electric tramways. (15 3/17.) 113,850.

3,768 Troup, Curtis & Co., & Wickett, J. H. Brush gear for dynamo-electric machinery. (15 3 17.) 113,686.

3,874 Igranic Electric Co. (Cutler-Hammer Mfg. Co.) Tubular demountable resistance units for rheostats. (16 3 17.) 113,854.

4,116 Wheatley, D. Y. Means for coupling a magneto-generator with an internal combustion engine. (21,3 17.) 113,859.

4,464 Wilkinson, H. T. & Wardle Engineering Co. Lanterns or fittings for incandescent electric lamps. (28,3 17.) 113,698.

5,038 Raling, A. H. & Garrard, C. C. Electric switchboards. (11/4/17.) 113,705.

6437 Symes, H. Micro-telephone for use in automatic exchange systems. (26,6,16. 108,463.

7,442 Kronenberg, R. Method and means for electrically welding and shaping the rims of wheel tyres. (23 5/17.) 113,883.

8 659 Electric & Ordnance Accessories Co. & Langrish, N. G. Controlling or regulating devices for electric motors. (16,6,17.) 113,729.

Relates to means for producing an electrical interlock between the starting switch and the field regulator comprising a coil or electro-magnet connected with the starting resistance and adapted on the occurrence of an overload during the operation of [illegible] switch, when closed to short-circuit the field resistance, re- [illegible] ing resistance is short-circuited, when it is opened mechanically by the [illegible]

9,014 Bibby, J. Electric transformers, especially suitable for use in connection with [illegible]

9,024 Conner, M. S. & Puckette, C. C. Lubrication of magneto-electric machines. (23 6 17.) 113,732.

9,496 Harwood, A., & Bennett, F. H. Trolley heads of electric tramcars and the like. [illegible]

[illegible]

12,858 [illegible]

[illegible] Holders for electric incandescent lamps. (17 9 17.) 113,757.

[illegible] 113,765

[illegible]

APPLICATIONS FOR PATENTS.

[illegible]

February 26, 1918.

3,351 Crammond & Falconbridge. Electric signalling apparatus.
3,379 Sandycroft & Hunt. Alternating-current machines adapted for synchronous working.
3,381 Edwards. Prevention of ice coating of electric traction conductors.
3,395 B.T.-H. Co. (G.E. Co.) Speed regulators.
3,396 Dearlove. Insulated conductors.
3,408 Harrison & Hough. Electric light fittings and brackets.
3,414 [illegible]
3,418 Brown, Bouverie et Cie. High-voltage distributors for ignition apparatus. (14,3/17, Germany.)
3,420 Humbert. Making metals in electric furnaces.
3,430 [illegible]
3,431 Arzano & Clerici. Manufacture of iron by electrolysis. (19 3 17, Italy.)
3,433 [illegible]

February 27, 1918.

3,436 Gossage. Electric oil heater.
3,440 Greville. Electro-medical apparatus.
3,446 Pinkney. Electric height indicator.
3,452 Silberrad. Electric cells.
3,457 Wallace. Electric reversing switch mechanism.
3,460 Watson & Co. & Travis. Supply of electrical energy to furnaces, &c.
3,478 Davis. Attachment of telegraph wires to insulators.
3,480 Austing. Combination of telegraph and telephone apparatus.
3,495 Meidell. Transmission of micro-oscillations. (27,3,17, Norway.)
3,497 Plaisant. Dynamo-elecrtic machines.
3,530 Western Electric Co. & Polinkowsky. Machine switching telephone exchange systems.
3,532 Autonoff. Carbon conductors.

February 28, 1898.

3,541 Hall. Eletcrification of the soil for farming.
3,542 Hall. Eletcrification of seed and grain.
3,548 Howard. Electric cables.
3,575 Burleigh. Dynamo-electric machines.
3,577 [illegible]
3,584 Phillips. X-ray tube stands.
3,601 Stothert & Pitt & Franklin. Electric motors.

March 1, 1918.

3,617 Thompson. (Officine Elettro-Mecanische.) Starting switches for electric motors.
3,623 Howard. Jointing electric cables.
3,643 [illegible]
3,656 [illegible] projectors. (19/6/17, U.S.)
3,660 Antonoff. Electric batteries.

March 2, 1918.

3,676 Taylor. Transmission of electrical energy.
3,690 Burleigh. Dynamo-electric machinery
[illegible]
3,718 Broc. Couplings for electric circuits. (14,3,17, France.)
3,722 Vickers Limited & Stedman. Switches for controlling electric motors.
3,726 Bibby. Electric furnaces.

March 4, 1918.

[illegible]

March 5, 1918.

3,803 [illegible]
3,804 [illegible]
[illegible] Dynamo-electric machinery.
[illegible]
[illegible] Electrical separation of suspended [illegible]
3,846 [illegible]
[illegible] internal combustion engines.
[illegible]

Commercial Topics.

Mica Control.

The Minister of Munitions has ordered that no person shall, until further notice, purchase or take delivery of any mica in the United Kingdom except under a licence issued under his authority, or sell or deliver any such mica to any person other than the holder of a licence.

N[illegible] any manufacture or work except in [illegible] the terms of a licence. All persons shall send to the [illegible] Non-Ferrous Materials, MS R1, Ministry of Munitions, 8, N[illegible] W.C. 2, such returns with regard to their stocks, [illegible] of mica and any contracts or orders made or given to or by them requiring for their execution the use of mica as shall from time to time be required.

Applications for licences should be made to the Controller of Non-Ferrous Metals, and marked "Mica Licence." The expression "mica" means block mica of the following quality and size grades: [illegible] only "of best" or Government standard quality, or suitable for use in the manufacture of magneto condenser plates, in size grades No. 3 to No. 6 inclusive, or their equivalent in rectangular or other trimming, and include mica coming within the above definition when split from block of any quality.

* * * *

Dealings in Small Tools.

It is notified that the undertaking to be signed by or on behalf of dealers in engineers' and machinists' imported small tools has been cancelled. The Ministry of Munitions has, however, imposed the following regulations with regard to priority classification in respect of all small tools, whether imported or of British manufacture:—

N[illegible] is permitted to issue a class "A" certificate with an order for small tools unless (a) such small tools form a component part of a direct Government contract, or (b) specially authorised in writing [illegible] Priority Department of the Ministry of Munitions (applications for such higher priority must be made through the Director of Small Tools [illegible] Buildings, Embankment, W.C. 2.)

[illegible] "A" certificate must bear the contract number in the case of (a) and the priority permit number and classification in the case of (b). Firms holding a P.5 maintenance permit are authorised to quote their maintenance permit number and priority classification on orders for [illegible] under their maintenance permit. All other firms and persons placing orders for small tools required for [illegible] should issue a class "B" certificate with their order. Orders for small tools without certificates may only [illegible] from stock and without prejudice [illegible]

[illegible] may issue a class "B" [illegible] only dispose of such small [illegible] the back of the certificate. Bona-fide munition workers, or soldiers engaged on mechanical work, [illegible] "B" certificates. [illegible] to the general public without [illegible] without certificate. [illegible]

Income Tax Allowances for Plant Depreciation, &c.

[illegible] 1897 an allowance for [illegible] to capital. As an [illegible]

to increase in capital, after deducting the scrap value or realised price of the plant and machinery replaced. Buildings and wasting assets, such as mines, annuities and leasehold interests, do not come within the scope of the allowance for depreciation.

In "controlled" concerns the income tax allowance has been temporarily extended. This allowance prevents the hardship that would otherwise arise owing to the circumstance that controlled establishments, being held at the disposal of the Government, may be required to alter completely the course of their business and to undertake exceptional expenditure which may be of little or no post-war utility to them. The Finance Acts of 1916 and 1917 accordingly authorise the Commissioners to revise the allowance so as to enable a deduction to be made from profits of the difference between cost and post-war value of installations and extensions (including buildings) which would not have been undertaken but for the war and the express requirements of the Government.

* * * *

Electric Furnace Progress.

At a recent meeting of the Western Society of Engineers, Mr. Norman T. Wilcox said that the rapid growth of the use of electric steel furnaces in the United States was the result of the efficiency of electric power, and had mainly occurred within the last five years, the greater portion of the increase occurring in the last year or two.

Up to March 1, 1917, at least 158 steel-making electric furnaces had been contracted for, or were in actual commercial service, in the United States. Those furnaces, if operated 24 hours a day (six days in a week) would have a total capacity of 1,000,000 tons of steel per annum. The production of a million tons of steel made from cold scrap would represent at least 600,000,000 kw.-hours per annum. Because of its uniformity, greater freedom from segregation, and its greater homogeneity, electric steel was somewhat higher in tensile strength and elastic limit than steel made by other processes. Owing to its greater density the electric steel showed a marked resistance to fatigue. Small furnaces had been developed even in the polyphase type down to capacities as low as ½ ton of metal per heat. A furnace of that size would require from 100 to 125 kw., and when operated polyphase would run on a power factor of approximately 90 per cent. The larger furnaces as now installed require for most efficient operation approximately 250 kw. ton of metal per heat. Electric furnaces could not be expected to take the place of the ordinary cupola, such as is used for the making of common grades of cast-iron, but they were the only apparatus which would successfully produce all grades of material from and in the same furnace.

In Canada there are now 54 furnaces running with a capacity of 173,000 tons of iron and steel, 50,000 tons of ferro-silicon, and 8,000 tons of ferro-alloys per annum. One firm have a capacity of 72,000 tons of electric steel per annum. The total production of steel ingots and castings during the first nine months of 1917 was 1,265,183 short tons, against 911,054 tons during the corresponding period of 1916. The production of steel in electric furnaces was 30,960 tons, against 19,639 tons.

In England we are only just realising the immense possibilities of the electric furnace for steel and castings, but the need of very high-grade alloy steels for aircraft has given a great impetus to the electric furnace industry here. Some of these intricate alloy steels can only be successfully made in the electric furnace, but it is not yet realised that all steels except the very cheaper basic qualities can with advantage be treated electrically—either complete melting or refining hot metal only. The increasing shortage of hematite pig iron will undoubtedly give the electric furnace a fair opportunity of proving what it is capable of, and it is to be hoped will remove some of the fears and scruples that in the past have prevented its being more widely adopted.

One firm in the United States have under installation a number of furnaces of 15 and 25 tons capacity, the output of which will more than equal our total pre-war electric steel production. Five years ago there were only 19 furnaces in the States and three in Canada; to-day the figures are 233 and 51 respectively. We are pleased to see that the American Navy Department have adopted an English type of furnace, the "Greaves-Etchels," and are building a number of 6-ton units [illegible] navy yard. The same furnace has also been adopted by [illegible] Matthews, of the Halcomb Steel Co., and by the American [illegible] Co. Judged by the eagerness of the steel trade throughout America to adopt the new process of electric melting, it is evident that the steel makers there are hastening to place themselves in a position [illegible] to meet the expected call for vast quantities of electric [illegible] the return of peace.

[illegible] would undoubtedly have been much more marked [illegible] the movement received a check some 12 months or more ago [illegible] applications for permit to install furnaces were refused, and, as a result, several firms desirous of providing themselves with electric melting plant have deferred the matter until the embargo is removed, although they are quite satisfied that for future business the electric furnace is essential for the success of the British steel industry. Recently [illegible] attention has been given by the authorities in charge of steel production to the importance of the electric furnace industry.

New electric furnaces have successfully been started up at the Leyland Motor Works (Leyland) and at Messrs. Stewarts & Lloyds (Glasgow). [illegible] the 3-ton Greaves-Etchels furnace was adopted. They will both run on high-grade steel castings. The shortage of pig iron [illegible] be held for melting up turnings and scrap by the [illegible] furnace, [illegible] to say that any works with an excess of [illegible] scrap and who buy castings could with advantage install electric [illegible] the whole of the charge can be made up of such material and the finished product is superior to ordinary steel castings.

Electricity Supply.

Extensions.

Greenock.—The Finance Committee recommend that application be made for power to borrow £82,000 for additional generating plant and mains extensions.

Pembroke.—An unopposed inquiry was held on the 10th inst. into the application of the Urban Council to borrow £10,000 for extensions of the electric supply undertaking.

Wigan.—The Council has applied to the L.G. Board for sanction to borrow £65,000 for extensions of the electricity undertaking.

General.

Blackpool.—A preliminary report has been prepared by the borough electrical engineer (Mr. Chas. Furness) upon the generation, transmission and distribution of electrical energy for lighting, heating and power within a radius of 10 miles from Blackpool.

Mr. Furness states that the extension of the county borough of Blackpool, now absorbing Bispham with Norbreck, increases the coastal length of the enlarged borough from 4 to 7 miles, and the total area from 4,349 to 6,167 statute acres. The development of this new area in the near future will demand that the public utilities of the borough, particularly that of electricity supply, shall be extended, and this question is undoubtedly of great importance if Greater Blackpool is to be made an attractive residential town, and every encouragement therefore should be given to architects, surveyors and builders to lay out their estates and property, for the general adoption of electricity for lighting, heating, cooking and domestic power. The electric service comes next in importance to that of water and public health, and the residence of the future will undoubtedly call for the most efficient and up-to-date equipment for the saving of domestic labour, and unless the Corporation take a broad and long view of the prospective demands for electricity, the borough will not be able to maintain its present position of prosperity. The permanent prosperity of the borough is quite as much concerned in building up an attractive residential colony as in catering for the summer visitor, and therefore the public services, such as water, transportation, lighting, power, &c., should be quite up-to-date, efficient and attractive, not only in the town proper and along the Promenade, but in the suburban and residential parts of the borough. The public services which it is his duty to foster and promote in this connection are those of electricity supply and transportation. Blackpool has a reputation for pioneer work in this direction dating back to the early days, when electric lighting and electric tramways were experimental, and when the number of municipalities administering such concerns could be counted on the fingers of one hand. To-day, electricity supply and tramways within the old borough have reached a very high standard, their growth has been well maintained, and few towns are better served than Blackpool in regard to these public utilities. In normal times the number of new houses built within the old borough averaged 550 per annum, and when the present restrictions upon building developments are removed there will undoubtedly be great building activity to recover the rate of increase lost during the past four years, and it will, therefore, be necessary to make extensions of plant and [illegible] to meet the [illegible] increased demands for both lighting and [illegible].

Referring to the report of the Coal Conservation Sub-committee of the Ministry of Reconstruction, Mr. Furness states that the conclusions drawn from it [illegible]

[illegible]

unit (prime mover) the latter results per horse power. The capital cost,

[illegible]

to existing consumers at 500/250 volts, but to make preparation for closing down entirely the gas plant and realising upon same as soon as the Local Government Board remove the present restrictions as to capital expenditure, &c. Unfortunately, the change over from direct current at 250 volts to alternating current at 200 volts will necessitate a complete change of meters, lamps, motors and accessories at Bispham. The number of consumers does not exceed 300, and Mr. Furness estimates the cost of bringing the various consumers' installations into line with the Blackpool pressure will be £1,800. The further cost of linking up the Bispham electricity feeders and distributors with our own network is a distinct matter, and, as the question of feeder extensions was involved with the future policy of centralisation of generation, it would be necessary for the Corporation to determine their policy in regard to electricity generation, taking a long view of the requirements of "Greater Blackpool" and the surrounding districts during, say, the next 15 years, before he could prepare an estimate of the cost of cable extensions, &c.

Mr. Furness considers the time is now opportune for the question to receive the serious consideration of our Corporation and the adjoining authorities with a view to a conference to discuss fully the desirability or otherwise of establishing either one authority or a joint electricity board to control and administer the generation and transmission over trunk feeders of all electrical energy required within a radius of 10 miles of Blackpool. In that event an extra-high-tension three-phase 50-periodicity system would be adopted at 6,600 or 8,000 volts to meet the demands of the Fylde district, estimated at 37 million units per annum 15 years hence. Centralisation of generation and transmission for the Fylde from one conveniently situated power house did not mean scrapping existing distribution cables, motors, meters and accessories in the adjacent urban districts, as the extra-high-tension supply through trunk mains would be converted in the several areas at the existing stations or new sub-stations by rotary converters to suit the particular character of the existing distributing networks and the consumers' supply pressure. He recommends that the authorities interested be approached by Blackpool with a view to a joint conference of representatives to consider the desirability of centralisation, and that a provisional agreement pending the preparation of a scheme be entered into on the following lines: (1) "That no contract for extensions of generating plant (steam, gas or electric) be made by any of the Councils or parties pending the consideration of a scheme of extra-high-tension generation and transmission. (2) That no contribution towards the rates of any authority be made out of electricity funds in the meantime. The controlling authority would administer the generation and distribution of electricity so that no profit should be made for benefiting the rates of any community, but in the event of any surplus beyond a reasonable margin to meet contingencies being obtained, the price of electricity should be adjusted to absorb the surplus profit." A far greater benefit would be [illegible] upon the communities affected between Lytham and Fleetwood by low electricity tariffs rather than in a policy of fixing charges high enough to enable surplus funds to be secured for rate-aid purposes. In conclusion, Mr. Furness states [illegible] will be exhaustive and searching in seeking a solution to the present inefficient method of electricity generation and supply, and that the views of the municipal authorities within a 20 mile radius of Preston shall also be [illegible] conveniently situated near the Preston Docks or other suitable site in [illegible]

Co-operation in London Electricity Supply.—[illegible]

Darwen.—[illegible]

Linking up in Newcastle.—[illegible] counties.

Marylebone, London.—[illegible]

a trying period, their whole association was harmonious. Mr. Seabrook had been appointed to a position of national importance, and the Electricity Committee had accepted his resignation with the greatest regret.

National Kitchens.—Of the three National Kitchens to be established in Hackney (London) one is to be fitted for the use of gas and two for electricity.

The Electricity Committee is to provide the electric cooking apparatus, at the same price as the apparatus in the gas kitchen, and maintain the two electric kitchens at the same price per kitchen, as the gas kitchen. The Electricity Committee will further supply fuel and electrical energy to the electric kitchens at the same price per portion served as the cost of fuel per portion served in the gas kitchen.

Sheffield.—The Electric Supply Committee report that negotiations had taken place on the basis that the cost of linking-up cables, transformers, &c., for connecting the Sheffield and Rotherham power stations would be approximately £50,000.

It is estimated that the annual expenditure will be £4,000, of which it had been assumed that each Corporation will pay one-third and the Ministry of Munitions one-third. It has now been arranged that Sheffield Corporation will pay the whole cost and bear the cost of the repair and maintenance of the works, which shall be their property. In view of this arrangement and on the understanding that the Ministry of Munitions will contribute one-third of the capital cost of the works, Rotherham Corporation will make a deduction from the price to be paid for current supplied by them to Sheffield under the present scheme at the rate of £130 per million units sold (0·0312d. per unit) up to 10,000,000 units a year.

Stretford.—The salary of the electrical engineer (Mr. R. Rowland) has been increased by £25 per annum.

Swansea.—The electrical engineer (Mr. J. W. Burr) has been directed to obtain prices for the supply of coal conveyors for taking coal from trucks to the front of the boilers.

Electric Traction.

Bradford. In response to the request of the Tramways Committee, the Admiralty have decided, with great reluctance, to release the tramways manager (Mr. Spencer), and they thank the Council for their patriotic spirit in lending Mr. Spencer's services to the Admiralty for 13 months.

The Board of Trade inspector (Col. Pringle) has issued his report on the tramway accident which took place on Feb. 1 on the Allerton section of the Corporation tramways.

A car which was travelling along Allerton-road left the rails on the curve at the junction of that road with Chapel-lane and overturned, resulting in one death and injuries to nineteen passengers.

Col. Pringle [illegible] that the accident was caused by speed very [illegible] authorised, and that there was no failure in brake [illegible] for the high speed attained. Fog and [illegible] contributory factor, to the extent that the [illegible] whereabouts. He recommends that [illegible] compulsory stopping place be altered in [illegible] in future, that certain altera[illegible] for Allerton-road, and that [illegible] Board of Trade compulsory stopping places, be [illegible] red lamp.

Electrical Vehicle Charging Stations.—The General Vehicle Co. [illegible] W. [illegible] has published a map [illegible] for electric vehicles within a [illegible]

[illegible]

Ex-Soldiers as Tramway Employees. [illegible]

Glasgow. [illegible]

Lancaster. [illegible]

proposed to run 12. The increased service was the outcome of recommendations by a Government department. The estimated cost of the additional eight was £1,100 to £1,200 each. The success of the Lancastre electric service had induced Morecambe Corporation to seek powers to run a similar service.

Northampton.—The salary of the tramways manager (Mr. M'Mahon) has been increased from £350 to £400 per annum.

Foreign Notes.

Manchuria.—A British consular report from Dairen states that the Electrochemical Industry Co., of Tokio, has installed plant at Fiushun for the production of carbide sulphate of ammonia, &c.

Morocco.—The British Consul at Fez reports that the company holding the concession for electric supply in that city hope to import sufficient plant to generate 2,250 kw., and to have it working by January, 1919.

The electrical plant has been ordered in France. It is hoped to utilise the water-power of the Oued Ben Kherareb Falls after the war, and supply current at Mequinez as well as at Fez.

The Electrical Industry in Germany.—From reports in the German newspapers it is evident the electrical industry has lately experienced exceptional difficulties in obtaining supplies of raw materials.

Owing to the recent reduction in water power due to the cold weather, electricity works in Munich are compelled to work at higher pressure on week-days, thereby increasing their coal consumption. According to the "Neuste Nachrichten" it is now provided that, where necessary, work in Munich armament industries shall be suspended on a week-day, and that Sunday labour shall be substituted, in order to enable electricity works to utilise the water-power hitherto unused on that day.

The coal shortage is creating a more difficult situation. The Imperial Commissary for Coal Distribution has imposed further restrictions, and the coal supply to electricity works will be reduced "to about 70 per cent. of the intended quantity," and it is stated that stoppages in the coal supply must also be reckoned with. Consumption must therefore be duly restricted in order to avoid as far as possible a complete stoppage."

Severe tramway restrictions are to be effected in Berlin, and the electrical works of greater Berlin are at the limit of their output capacity, "partly due to the erection of a good deal of new electrical plant by large consumers." Dresden is also suffering similar difficulties, and the authorities there have issued an order prohibiting the use of electric motors on working days between 4 and 8 p.m., and restricting the hours during which electric light may be used by shops and other business premises. Drastic restrictions were effected in the Bremen tramway service as from Jan. 8, owing to the Metal Collecting Office expropriating the trolley wire which the authorities were obliged to surrender.

Miscellaneous.

Application for Leave to Amend Specification.—Mr. H. A. Gill, on behalf of the United States Light & Heat Corpn., seeks leave to amend the specification of letters patent No. 113,258, for "Improvements in variable-speed generators and storage battery systems. Particulars of the proposed amendment were published in the "Official Journal (Patents)" of April 10.

Education Estimates.—The Civil Service estimates dealing with education, scientific and industrial research, &c., have been issued for the year ending March 31, 1919.

A total of £163,350 is allocated for scientific and industrial research, including £89,750 for the National Physical Laboratory, £7,000 for the Fuel Research Station and £56,500 for grants for investigation and research, which will be distributed by a Committee of the Privy Council. The net total allocated to the Board of Education is £19,206,705, an increase of £190,925. Under this head there is a sum of £32,150 for the Imperial College of Science and Technology and Chelsea Physic Garden, £13,435 for the Science Museum, £1,568,570 for expenditure on secondary schools and pupil teachers, &c., and £422,209 for the training of teachers. A grant of £6,000 is made to the Royal Society, £3,000 to the Solar Physics Observatory, £22,500 to the Meteorological Office and £90,022 to the British Museum.

The New National Service Order.—The Order issued by the Director General of National Service (Sir Auckland Geddes) last week, and which comes into force on 24th inst., will have the effect of withdrawing exemptions in thousands of cases. This does not affect the certificates held by miners, transport workers and munition workers under the schedule of protected occupations.

In the trades mentioned in Part I. of the Schedule men in category A, B 1 or C 1, or Grade 1 or 2 and up to the age of 43 are deprived of exemption. These are mainly luxury trades.

Men in the trades in Part II. also lose their exemption if they are in Category A or Grade A, or have not been placed in a Medical Category or Grade. These include: engineering works and foundries, foremen, if born in or after 1885; fitter, turner, erector, pattern maker, moulder or other skilled workman if born in or after 1883, and all other classes of workmen in engineering works and foundries not specified, if born in or after 1875.

The exemption of men of the following classes under the medical classes mentioned for Parts I. and II. of the Schedule are withdrawn if the men were born in or after the years mentioned. *Engineman or engine tenter, including driver of works locomotive, 1883; steam power crane driver, 1883; *steam boiler fireman, 1883; maintenance and repairing staff—mechanic, electrician or electrical fitter, mill joiner, bricklayer or other skilled man wholly or principally engaged in the maintenance or repair of his employer's plant, machinery, or tools, 1885; machine tools—tool maker, tool fitter, tool setter, die sinker, tool hardener, 1890.

* If the man is the only man of his occupation in his shift, his certificate of exemption is not withdrawn although otherwise it comes within the terms of the Schedule.

Winding-up Petition.—A petition for winding-up Carl Zeiss (London) (Ltd.) has been presented by the Board of Trade, and will be heard in the High Court on April 16.

Tenders Invited and Accepted.

E.H.T. and L.T. Switchgear.

NEWPORT (MON.) Corporation invite tenders for e.h.t. and l.t. switchgear. Forms of tender, specification and drawings from the borough electrical engineer and tramways manager, Mr. A. Nichols-Moore, M.I.E.E. Tenders to the town clerk, Mr. A. Newman, Town Hall, Newport, Mon., by 10 a.m. May 1. *See also an advertisement.*

Switch Panel.

MANCHESTER Electricity Committee require tenders by 10 a.m. April 24 for supply and erection of d.c. machine panel for controlling 2,000 2,400 kw. motor converter at Dickinson-street station. Specification from Mr. F. E. Hughes, Town Hall, Manchester.

Cooling Tower.

SUNDERLAND Corporation invite tenders for the supply and erection of one forced-draught cooling tower. Specification and tender from the general manager, Mr. Alfred S. Blackman, Electricity Offices, Dunning-street, Sunderland. Tenders to the town clerk, Mr. H. Craven, Town Hall, Sunderland, by first post April 24. *See advertisement.*

Boilers, Economisers, &c.

DUBLIN Electricity Committee Supply require tenders by noon April 23 for the supply and installation of water tube boilers, economisers, pumps, pipework, boiler seatings, fluework, &c., at their Pigeon House generating station. Specification, &c., from the City Electrical Engineer.

Turbo-alternator, Converter, &c.

PLYMOUTH Corporation require tenders by April 29 for turbo-alternator, converter, transformers and switchgear. Specifications from the Borough Electrical Engineer.

CAVAN.—The Guardians have accepted the tender of Edmundson's Electricity Corporation for the supply and erection of a storage battery (£[illegible]), overhead mains, &c. (£[illegible]), and an overhead main to the tuberculosis hospital (£[illegible]).

GLASGOW.—The Tramways Committee has accepted the tender of [illegible] Bolton & Sons [illegible] and that of Pilkington Bros. for glass.

[illegible].—The Council has accepted the tender of the Staveley Coal & Iron Co. for supply and erection of circulating water discharge pipes at the new power station.

Appointments Vacant and Filled.

An electrical engineer is required to take charge of electric supply in Africa. Applications to Mr. W. M. [illegible], [illegible] Victoria-street, S.W. 1. [illegible]

An [illegible] required in electrical laboratory [illegible] for standardisation of instruments and materials and general research work.

A [illegible] with experience in construction of scientific instruments is required [illegible]. *See advertisement.*

A meter test room assistant is required with good experience. *See advertisement.*

Mr. A. [illegible] has been appointed meter superintendent to the Calcutta Electric Supply Corporation at a commencing salary of [illegible] per annum [illegible] 10 per cent. war bonus and [illegible] per year living allowance.

Oldham Council have appointed Mr. Wm. Chamberlain [illegible] general manager of the [illegible] department [illegible] general manager of the Corporation tramways [illegible] Mr. [illegible], who has been appointed deputy [illegible] of the Liverpool Tramways.

Mr. A. R. [illegible] has been appointed deputy electrical engineer of Bath at £[illegible] per annum.

Business Items.

Messrs. Ferguson, Pailin & Co. (Ltd.), electrical engineers, Openshaw, Manchester, have opened an office at 37, Norfolk-street, Strand, London, W.C., in order to give better attention to their numerous clients in the London area. Telephone, City 547.

Plant for Sale.—An advertiser has for sale two 250 B.H.P., two 100 B.H.P., and one 12 B.H.P. slip-ring type motors.

Patent Development.—The owner of patent No. 8,654 1914, for "Keyboard type perforating apparatus," desires to license or sell the patent rights in this country for Great Britain. Applications to Messrs. E. P. Alexander & Son, 306, High Holborn, London, W.C.1.

Pole Line Contracts.—The British Insulated & Helsby Cables, Ltd., of Prescot, Lancs, has issued a list giving particulars of 174 contracts for pole lines in hand or erected by the company in the United Kingdom at Dec. 31, 1917.

The list, which is confined to lighting and industrial power lines, shows that the company has executed contracts for 335 miles run of overhead equipment for lines ranging from 220 to 20,000 volts, and at the latter voltage 37 lines, covering 126 miles of equipment, were erected. The list also gives some information regarding Prescot pole line accessories, suspension insulators, inverted terminal boxes, &c.

Liquidations, &c.

A meeting of creditors of the Electricity Supply Co. for Spain (Ltd.) will be held at Dunster House, Mincing-lane, London, E.C. 3, on April 24.

A meeting to receive an account of the winding up of the Electric Utility Co. (Ltd.) will be held on May 23 at 50 & 51, High Holborn, London, W.C. 2.

Calvert's Circulation Fuel Economiser (Ltd.) is being wound up voluntarily, and Mr. F. J. Drane, 36, John-street, Bedford-row, London, W.C.1, has been appointed liquidator.

Deed of Assignment.—Claims against Basil Chas. Cousens, electrical engineer, Wyre Dock, and 6, Albert-square, Fleetwood, under a deed of assignment executed by him on July 28, 1917, are to be sent by May 3 to Mr. Jas. Todd, 18, Birley-street, Blackpool.

Companies' Meetings and Reports.

Chelsea Electricity Supply Co. (Ltd.

The annual ordinary general meeting was held on April 10, Mr. W. E. DAVIES, the chairman of the Company, presiding.

The CHIEF ENGINEER AND MANAGER (Mr. Percy Sell, M.I.E.E.) having read the notice convening the meeting and the auditors' report,

The CHAIRMAN said: Gentlemen, the accounts before us are so abnormal that some detailed examination may be desirable. You will notice that the total receipts amount to no less than £[illegible], by far the largest in the history of the Company. This is an increase of £[illegible], or 13[illegible] per cent. over the previous year, and is made up of £[illegible] from [illegible] and £[illegible] sundry [illegible]. [illegible]

[illegible]

the pre-war rate and compares favourably with the rise in the price of gas, which in the case of the two principal London gas companies is 53 per cent. increase in one case and 66 per cent. in the other. Turning to the prospects for the current year, I can only echo what the chairman [illegible] every electric light company has told his shareholders—that we are in for a difficult and anxious time. In addition to the continuing rise in rates of wages, we are faced with the fact that under the operation of the new Order by which all domestic consumers, with the exception of the very small ones, must reduce their demand by one-sixth, we must look forward to a decreased output for the current year. The latest increase in price of 10 per cent. will not compensate for the recent increased cost in wages and materials, let alone affording any compensation for the demand on us being compulsorily reduced. Our work has been carried on under continually increasing difficulties. Our chief engineer and manager (Mr. Still) and our secretary (Mr. Cluer) and their staffs have rendered us devoted service, and I am glad of this opportunity of acknowledging the fact. I now beg to move the adoption of the report.

Major WOODS seconded the resolution, which was carried unanimously. The retiring Director (Mr. H. R. Beeton) was re-elected, and the auditors (Messrs. Cooper Bros. & Co.) were re-appointed. A vote [illegible] to the Chairman, Directors and staff was passed.

BRITISH ENGINE, BOILER & ELECTRICAL INSURANCE CO. (LTD.)—[illegible] last week the chairman (Mr. R. Charles Longridge) said that there had been a marked development in the business of the Company, the inspection fees and premiums having increased to £141,875, against £125,851 in the previous year. The explanation of the increase was that a very large amount of additional electrical plant had been insured with the Company in order that the owners might have the benefit of the Company's inspection services. Many firms had candidly told the Company that whilst in the past they had been prepared to run their own risks, they now felt that with plant in charge of insufficiently experienced workpeople it was desirable to take the precaution of having it under independent inspection with a view to preventing stoppages. Other clients had been much impressed by the increased cost of effecting repairs and were also influenced by the fact that it was an advantage in the event of a breakdown to have the assistance of the Company's engineers both in deciding what repairs should be carried out and in attending at the repairing shops to see that the work was satisfactorily completed. He felt they were performing a work of great national importance through regular inspections, by obviating the necessity for repairs and thus relieving the strain upon workshops. Provision had been made for writing off further depre[illegible] to the extent of £4,913, and after making provision [illegible] the total funds of the Company were £185,462.

MARCONI WIRELESS TELEGRAPH CO. OF AMERICA (LTD.)—The [illegible] 1917 [illegible] the declaration of war with Germany, the Director of Naval Communications took over all radio stations in [illegible] and commercial traffic was suspended. The Massachusetts stations, intended for communication with Scandi[illegible] construction, had also been [illegible] being pushed forward as rapidly as possible. All those stations were operated or will be [illegible] traffic, subject to censorship. Reasonable rental compensation arrangements had been agreed [illegible] certain plants and on [illegible] of others. The [illegible] in Aldene (New [illegible] that it had more [illegible] had increased [illegible] and was turning [illegible] the many problems [illegible] the organisation [illegible] the zone of [illegible] The new Com[illegible] South [illegible] \$17,772, [illegible] from [illegible]

[illegible]

City Notes.

ALTRINCHAM ELECTRIC SUPPLY (LTD.)—The directors have declared a dividend of 3s. 6d. per share on the deferred shares.

ANGLO-AMERICAN TELEGRAPH CO. (LTD.)—An interim dividend has been declared for the quarter ended March 31 of 15s. per cent. on the ordinary stock and £1. 10s. per cent. on the preferred stock (less tax).

DIRECT UNITED STATES CABLE CO.—A final dividend of 2s. per share less tax, has been declared, making 4 per cent. for the year ended March 31 (the same as the previous year).

EASTERN TELEGRAPH CO. (LTD.)—The Company announce payment by warrants on May 1 of interest for the half-year ending April 30, on their 4 per cent. mortgage debenture stock. The transfer books of the stock will be closed from April 25 to 30, inclusive.

LANCASHIRE DYNAMO & MOTOR CO.—The permission of the Treasury has been received to the issue of 50,000 new ordinary £1 shares, at a premium of 7s. 6d. The present ordinary shareholders will be entitled to take up 45,000, and the staff will be allowed to take up the other 5,000.

SIR W. G. ARMSTRONG, WHITWORTH & CO. (LTD.)—The directors state that, as it will not be possible to complete the 1917 accounts for some time, they have decided to meet preference dividends, and pay for the half-year ended Dec. 31 last a dividend of 1s. 6d. per share (tax free) on the ordinary shares.

SUBMARINE CABLES' TRUST.—Holders of certificates to be redeemed out of surplus income (accrued to 15th inst.), and desirous of surrendering their certificates, should communicate with the secretary (Mr. Sidney Collett), stating the lowest price they are willing to accept.

VICKERS LIMITED.—A final dividend has been declared for 1917 o 1s. 6d. per share (tax free), making 2s. 6d. per share (12½ per cent.) for the year, free of tax, the same as for 1916.

The Round Table.

By "kVA."

Mr. Barnard's soliloquy from "The Chloride Chronicle" will, I am sure, be appreciated by station men :—

THE BATTERY ATTENDANT SOLILOQUISES.

When lugs and terminals remain
As first installed, secure and clean ;
When acid does not burn or stain
And verdigris no more is green ;

When lead-lined boxes cease to leak,
Or pitch-pine stands to rot and soak,
When taking records week by week,
And day by day, becomes a joke ;

When E.M.F. and Sp.G.,
Though unrecorded, pan out right ;
When Watts, whatever load there be,
Come smiling up throughout the night ;

When cell-inspections shall reveal
Exactly where the niggers are ;
When plates shall cease to scale or peal,
Or bulging, try to burst the jar ;

When all this fancy box-o'-tricks,
Is swept away for something plain
Some simple reservoir of bricks,
With taps to fill it from the main ;

When prudence shall not force the wise
To keep wax candles on the shelf ,
If lead by then has ceased to rise,
I'll buy a Battery myself !

A. S. B.

* * * *

Thirty-Seven Years Ago.

[From The Electrician, April 16, 1881.]

[illegible] Prof. W. E. Ayrton and Dr. Alder Wright are to be [illegible] Fellows of the Royal Society in June next.

[illegible] at Newcastle.—For the last few nights one of the principal streets in Newcastle has been illuminated by means of [illegible] electric lamps. The light is reported as being of a pure, [illegible] pleasant to the eye, and diffusing a clear glow around the [illegible] placed.

[illegible] A Reuter's telegram of April 10th says: "It is [illegible] that the Boers refuse to allow the reconstruction of the telegraph lines beyond [illegible]." Later information, dated [illegible] says: "The inspector engaged in the reconstruction of the Transvaal telegraph lines has been threatened by the Boers and ordered back with his men and materials. They are [illegible] opposed to telegraphic communications."

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CONTENTS.

Notes.

Electric Furnaces in Steel Making.

THE comprehensive Presidential Address delivered by SIR ROBERT HADFIELD to the Society of British Gas Industries will be read with interest by both gas and electrical engineers. It will certainly afford food for thought to gas engineers, who are reminded that, notwithstanding certain limitations and the statements on the part of gas people that electricity could never replace gas as an illuminating agent, or could prove a serious competitor in cooking, great progress has been made and history has shown these views to be very much at fault. On the other hand, the address gives the electrical engineer important information, and should induce him to consider the further possibilities of using electricity for heating in industrial operations. One such operation is, of course, the electric melting and refining of steel and the production of various steel alloys. Before the war the progress of the electric furnace was somewhat slow. Work under war conditions, however, has demonstrated to the full the great value of the electric furnace, and it is a startling fact to realise that in the works of Messrs. Hadfield alone 54¾ million kilowatt hours were used in 1917, about one-half of this being utilised for the [illegible] At the present time operations of this kind can be carried out without much consideration of commercial efficiency, but [illegible]

factor is often very high. Moreover, the power factor is reasonably good, so that from every point of view the electric furnace load is one to be encouraged.

Remuneration of Teachers.

ANOTHER subject to which attention is called by SIR ROBERT HADFIELD is the inadequate remuneration of teachers. In 1913-14, for example, the average salary paid to teachers in technical and polytechnic institutions was only £[illegible] per annum, comparatively few teachers having the chance of rising to more than £250. A reference is made to the same subject in the report of the Committee to Enquire into the Position of Natural Science in the Educational System of Great Britain, with which we dealt last week. More than half the amount spent in salaries goes to professors and heads of departments. We do not suggest for a moment that professors as a rule receive more than sufficient—it is often the other way about—but there is no question that there is widespread and serious discontent with salaries and prospects of the junior staff of the scientific departments. The view of the Committee is that the best way of improving the position of the junior staff is to decrease the time required for their official duties rather than to make large increases in their salaries. At present the tendency is to require so much teaching work that these members of the staff have few opportunities for research, and so are at a disadvantage when competing for posts for which distinction in research is an essential qualification. We are in full sympathy with this view, but even so, we think that the salaries should be raised. The best teaching cannot possibly be expected from men who are reduced to being mere hacks.

Coal Conservation.

WE give this week an account of a discussion which took place at Newcastle on the Report of the Coal Conservation Sub-Committee and which may be regarded as the counterpart of the discussion which was held at Manchester. At Newcastle, Mr. VERNIER presented the case from the point of view of private enterprise, whereas at Manchester Mr. PEARCE dealt with the matter largely from the municipal standpoint. It is well that [illegible] should be made by both parties. We cannot refer to all the points raised by Mr. VERNIER. Many of them are familiar, but it is of interest to note that his inclinations are not so much towards very large power stations, which present certain difficulties and dangers, [illegible]

Curtailment of Lighting and Saving of Coal.

SOME interesting points emerged from the Paper read by Mr. P. S. MILLAR before the American Illuminating Engineering Society in February last on the above subject. The author gave what we do not recall having seen presented in this country, an analysis of the consumption of electricity for lighting in the United States under various heads. By far the greater proportion of lighting comes under four headings—residence (24 per cent.), commercial (22 per cent.), industrial (19 per cent.) and street-lighting (14 per cent.). It would appear, therefore, that the directions in which it is most worth saving, from a statistical standpoint, are precisely those where undue economy would be detrimental in causing restriction of output, liability to accident or other evils. Light for advertising, where economies may justly be made, only forms 4 per cent. of the whole. After examining these various classes of lighting, Mr. MILLAR comes to the conclusion that in the national interest only quite a small reduction in consumption is practicable; indeed, in some cases (for example, in industrial lighting), he thinks the national interests demand *more* light and not less. The changes he recommends could only bring about a net saving of 360,000 tons of coal per annum—though we are bound to say that the net curtailment he deems desirable (3 per cent.) seems low in comparison with that which consumers are being asked to make in this country. There are, however, other directions in which much more imposing economies are possible. Mr. MILLAR states that if each family instead of diminishing its lighting were to reduce its daily coal consumption by one shovelful, the result would be a saving of 15,000,000 tons per annum, which approaches the 50,000,000 which the authorities desire to save; or if the temperature of the interiors of buildings in the United States were habitually maintained at 67° instead of 70°, this relatively small change would mean a saving of 10,000,000 tons per annum. Similarly, it is assumed that the substitution of central station power for private plants would save 13,000,000 tons, while, as a more remote measure, the electrification of the railroads would ultimately save no less than 40,000,000 tons per annum.

The Cooling of Transformers.

IT has long been recognised that one of the most important factors in determining the output of transformers is the [illegible] for cooling. When a transformer is situated in the open air, or with abundant air-space round it and free ventilation, the problem presents little difficulty. But in [illegible] where the atmospheric temperature is usually high, and the means for conveying away radiated heat are limited, difficulties are apt to arise. An interesting case is described by Mr. [illegible] in the "Electrical World." Transformers may be roughly grouped into three divisions: air-cooled, self-cooled oil-filled and water-cooled oil-filled. [illegible] has developed the type in which the oil is cooled by forced circulation externally. The last type is [illegible]. Mr. [illegible] had to deal with a transformer of the second variety situated in a Chicago sub-station, where the oil temperature rose to [illegible] and that of the room [illegible]. He converted the transformer from the second to the fourth variety by tapping the case and pumping the oil through a cooling system. The net result of circulating the oil was to increase the practicable output by [illegible] per cent., certainly a very striking result. It is suggested that the most favourable way of dealing with the problem is to cool the oil by circulating it through external coils rather than to pump water through cooling coils in the transformer case. For the large transformers of the future it is probable that external cooling will come into considerable favour.

Royal Society.—Yesterday the Hon. Sir Charles Parsons, F.R.S., delivered the Bakerian lecture on "Experiments on the Production of Diamond."

Rectification of Alternating Currents by the Corona.—The rectification of high voltages is an interesting problem, on which some experiments described by Mr. J. W. Davis in a recent Paper before the American Physical Society shed some light. Pressures as high as 42,000 volts have been rectified by the corona discharge in hydrogen. For a given gas pressure the maximum voltage which may be rectified is roughly proportional to the radius of the outer cylinder, provided that the inner cylinder is small compared with the outer. The rectification is practically perfect, but the efficiency is low, much energy being wasted in the discharge. The voltage at which discharge takes place may be considerably reduced by arranging for the discharge to be started by an incandescent wire.

Diesel Engine Users Association.—At the March meeting of the Diesel Engine Users Association reference was made by the Hon. Secretary to the work carried out by the Heavy Oil Engine-Fuel Committee, appointed by the Controller of Munitions Mineral Oil Production; particulars were given as to the method of making application for licences to buy tar oil, arrangements for tar oil distribution, various methods of using tar oil, and the granting of priority certificates to enable parts to be obtained to adapt engines for the use of tar oil fuel. In a subsequent discussion on the use of tar oil fuel in Diesel engines the development of various devices for burning tar oil and the varying nature of tar oils were discussed. The subject, which is of particular importance at the present time in view of the restriction in the imports of petroleum fuel oil, is to be again discussed at the following meeting.

Suggestions for the Safe Operation of Petrol Engines in Mines.—Technical Paper 174, issued last year by the Bureau of Mines, U.S.A., on the above subject contains a useful summary of the chief dangers attending the use of petrol engines for mining work. Their small cost and the ease with which they can be transported has led to a great extension in the use of such motors, although in some States the mining laws forbid the use of petrol or any petroleum product. The chief sources of danger are (1) fires resulting from leaky containers or careless handling of petrol; (2) explosions caused by ignition of accumulations of petrol vapour; and (3) poisonous gases from the engine exhaust. The bulletin treats each of these sources of danger in turn, and contains some sound advice and useful hints. A sketch of a suitable portable tank is given, and there are instructions for extinguishing petrol fires. Of special value is the series of brief directions at the end of the Paper, which embody the essence of the advice given. We notice that there are now quite a large variety of useful publications on petroleum technology available for free distribution. Copies of this list of publications may be obtained from the Director, Bureau of Mines, Washington.

Acid-proof Alloys.—Some experiments by Dr. R. Irmann, described in "Metall und Erz." and translated in the "Chemical Trade Journal and Engineer," have an interesting bearing on acid-proof alloys. It has been assumed that electrolytic corrosion tests of voltaic couples of two metals afford an indication as to the corrosion of the alloys of those metals. The investigation by Dr. Irmann of alloys of copper and nickel, to which tungsten and iron were further added, apparently disproves this assumption. Much depends upon the proportions and the formation of compounds. Irmann was in search of an alloy not to be attacked by strong hot sulphuric acid. An alloy of nickel with 20 per cent. of tungsten was more resistant in this respect than nickel alone; but was difficult to machine and expensive. To introduce tungsten into the nickel, he started from copper-nickel. A voltaic couple of nickel and copper gave an E.M.F. of 0·55 volt, which soon went down to 0·25 volt; nickel was dissolved, the copper becoming polarised with hydrogen. He then introduced other elements, especially tungsten, into the nickel-copper alloys, studying also the alloys of copper and tungsten. An alloy of

47 per cent. of copper and 4·98 per cent. of tungsten, proved highly resistant, and mechanically strong. The electric resistance was greater than that of constantan. Very good results were also obtained with ternary nickel-tungsten-copper alloys. But quaternary alloys, containing also iron, proved far superior to the ternary alloys.

Megaphones With Rectangular Apertures.—A recent Paper before the Chicago section of the American Physical Society by Mr. F. R. Watson describes some interesting experiments with megaphones having rectangular apertures. Rayleigh was one of the first to make experiments with apertures of varying section, including elliptical types, which appeared to possess certain advantages for fog-signalling. The author has extended these speculations to megaphones with rectangular apertures for conveying speech. When the horn was held with the long edge of the rectangular aperture vertical sounds were diffracted more than 90 deg. from the straight forward direction and were easily heard by observers at the side. A converse effect was noted when the long edge of the rectangular aperture was horizontal. It is suggested that such megaphones would have particular applications for addressing crowds, for phonographs, &c., where it is desired to spread the sound horizontally. The results also throw an interesting light on the mean wave-length of speech. The sound was diffracted by the narrow dimension of the aperture, but not the large one, and must therefore have an effective component with half its wave-length lying between these limits.

Cold Storage Research.—A Committee has been appointed by the Food Investigation Board of the Department of Scientific and Industrial Research to consider engineering and physical problems which arise in connection with the use of cold to preserve food, and to organise such research on these subjects as may be considered necessary.

The Committee is under the Chairmanship of Sir Alfred Ewing, K.C.B., F.R.S. The terms of reference are designedly wide so that its activities may be as little hampered as possible. They cover refrigerating machines and the insulation of cold stores in general, and in particular the application of refrigeration in ships, barges and railway vans for the conveyance of produce at low temperatures. No single committee can hope to possess an exhaustive acquaintance with all aspects of so wide a question. The work will therefore be helped forward by suggestions received from without, and the Committee would welcome suggestions as to specific questions on which further knowledge is needed. Any communication should be addressed to "The Secretary, Sir Alfred Ewing's Committee, Scientific and Industrial Research Department, 15, Great George-street, Westminster, S.W. 1."

The members of the Committee are:—Sir Alfred Ewing, K.C.B., F.R.S. (Chairman), Sir Richard Glazebrook, C.B., F.R.S., Commander C. F. Jenkin, R.N.V.R., Mr. S. R. Beale (Louis Sterne & Co.), Prof. H. L. Callendar, F.R.S., Mr. G. C. Haslam (J. & E. Hall, Ltd.), Prof. C. H. Lees, F.R.S., Mr. A. Macdonald (Superintending Engineer of the Commonwealth and Dominion Line, Ltd., of the Cunard Line), Mr. J. T. Milton (Lloyd's Register of Shipping), Mr. W. E. Stotham (Lightfoot Refrigerating Co.), Mr. J. Thom (London Central Markets Cold Storage Co.), Mr. F. A. Wilcox (J. & E. Hall, Ltd.), and Mr. A. R. T. Woods (H. & W. Nelson Line).

Ultra-Violet Energy and Its Properties.—In "Metallurgical and Chemical Engineering" Mr. M. Luckiesh gives an interesting summary of the direct practical sources and properties of ultra-violet energy. The ultra-violet region he divides into the *near ultra-violet* (400μμ–300μμ) adjacent to visible rays, the *middle ultra-violet* (300μμ–200μμ), and the *extreme region* (200μμ [illegible]). The behaviour of various transparent media to these regions is important. Most ordinary clear glasses are transparent down to 350μμ, but are practically opaque at 300μμ, though the special Uviol glass developed at the Jena works will transmit freely down to the latter wave-length. Fused quartz transmits down to [illegible]. [illegible] good results. Reference is made to various chemical effects of ultra-violet rays—*e.g.*, their action on silver salts in photography, their use to excite fluorescence and their breaching effect on coloured media. A special instance of the latter effect is their coloration produced in arc lamp globes containing manganese. Among the most useful applications of these rays is their destructive effect on bacteria. The subject of measurement is a difficult one. The photographic plate is, perhaps, the only means of detecting ultra-violet energy of the shortest wave-length. The influence on leakage of charge of an electroscope is used for certain regions. Photo-electric cells may be applied to the analysis of the near and middle regions, and, with a sufficiently intense source, the heating effect on a bolometer may be employed.

Obituary.

Deaths on Active Service.—The following deaths on active service are reported:—

We regret to learn that Lieut.-Col. [illegible] Hallam, who for some years before the war was in charge of Messrs. Dick, Kerr & Co.'s interests in Manchester, was killed in action on March 25. At the outbreak of war he obtained a commission as 2nd lieutenant in the Manchester Regiment, and by his meritorious service had reached the rank of lieut.-colonel in the same regiment at the time of his death.

Capt. Wm. Kings Armstrong (S. Lancs Regt.), who was killed in action on April 11, was formerly a student at the Manchester School of Technology and a student-pupil at the British Westinghouse Co.'s works at Trafford Park.

Sec.-Lieut. Douglas R. Dilworth-Harrison (Durham L.I.), who has been killed in action, was educated at Manchester and at the Durham College of Science. He served an apprenticeship in engineering, and was subsequently engaged in electrical work in Brazil.

Personal.

Mr. R. Stewart Bain, managing director, and Mr. G. W. Partridge, engineer and manager of the London Electric Supply Corpn. (Ltd.), have recently completed 30 years' service in the company. Mr. H. C. Carter, secretary of the company, after 29 years' service, has retired owing to ill health.

Mr. L. G. Byng (Grenadier Guards), a director of the General Electric Co. (Ltd.), and son of the late G. Byng, chairman of the same company, has been awarded the Military Cross for distinguished services during the recent battles on the western front.

Dr. R. S. Willows, head of the department of mathematics and physics at Sir John Cass Technical Institute, who was recently appointed research physicist to the Tootal Broadhurst Lee Co., of Manchester, has been presented with a silver tea service by his colleagues on the staff.

Mr. John Taylor, director of Messrs. Mather & Platt (Ltd.), is gazetted an Officer of the Order of the British Empire.

Mr. H. Mayston, director of telegraph engineering, has retired from the Indian Government telegraph service.

Arrangements for the Week.

FRIDAY, April 26th (to day).

Physical Society.

5 p.m. At the Imperial College of Science, Imperial Institute-road, South Kensington, London, S.W. [illegible]

[illegible]

TUESDAY, April 30th.

[illegible]

THURSDAY, May 2nd.

[illegible]

FRIDAY, May 3rd.

[illegible]

Large Batteries for Power Purposes.*

By E. C. McKINNON.

Battery-room Design.

The conditions under which the battery will be operated form a most important factor in the results obtained.

Aspect.—The aspect of the room is quite important. Powerful sun rays striking direct on portions of the battery will cause irregular working, the level of the electrolyte will vary, the specific gravity of the acid will be uneven, the chemical activity will be greater in some cells than in others, and it will be necessary to replenish with water more frequently.

Ventilation.—Ventilation is certainly important, but it should be confined mainly to the removal of gases. Strong currents of air tend to drive off some of the acid spray which would otherwise be trapped by the spray arresters.

Floors.—There is such a wide range of opinion as to the design of battery-room floors that the author hesitates to advance any rigid recommendations in this respect. In two or more storied buildings the trend is to employ reinforced concrete as a base. What to place on the base is more problematical, and the choice ranges between cement, tar, bitumen, asphalt, vitrified bricks or tiles, wood blocks and rubber sheeting. It is difficult to make an acid-tight floor with tiles or bricks set in cement. Asphalt is an excellent acid-proof covering, but it is not suitable to bear heavy concentrated weights, especially in a warm room. The best floor which can be used is probably one of vitrified brick or tile laid on concrete, with the joints pointed with an acid-resisting, asphaltic or bituminous compound. The author advocates a gradual slope of 1 in. in 10 ft. from end to end of the room, or from each end to the centre, terminating in gutters, and no fall or slope across the room.

Walls and Ceilings.—Whitewashed walls and ceiling are objectionable, as the lime flakes off. A cement facing for walls is good, especially if given a heavy coating of light coloured paint. Vitrified bricks make a sound durable job, but better appearance is obtained from glazed bricks or tiles. For appearance and durability, a wooden ceiling painted or varnished has much in its favour.

Fixtures.—Overhead lifting tackle should be provided, and in addition sufficient working space to carry out repairs. Facilities for re-plating and cleaning out a large battery should be considered when designing the room. A complete water supply system should be designed for the provision of distilled water.

Temperature.—The objections to very high temperatures are mainly that any impurities in the battery are more active at high temperatures, evaporation is excessive, the gas bubbles float in the air more readily, any acid spray dispersed concentrates more rapidly and [illegible] wood and metal work. The capacity of the battery is increased, consequently the plates can be overworked [illegible]. On the other hand, at low temperatures the capacity is [illegible] lowered, the mean voltage on discharge is lower, and the mean voltage on charge is higher. This results in a [illegible].

[illegible] their unwieldiness in heavy sections. The most satisfactory form [illegible]

[illegible]

Although competition has led to some attempt at standardisation by [illegible]

* [illegible] of a Paper read before the [illegible] of Electrical Engineers.

(a) Design of Cells.

When dealing with design of cells there are certain items in regard to plates, electrolyte, separators and containers that might be standardised.

Containers.—It may be accepted that all large batteries will be assembled in lead-lined wood boxes. The thickness of lead lining need not be more than 3½ lb. per square foot. Drainage between the lining and wood container is useful. The relative height of the container to the height of the plates may easily be standardised.

The depth of space below the plates should be deep enough to avoid frequent removal of the sediment (or trouble through electrochemical action on the lead linings will arise), but not so deep that the acid in the electrolyte gradually settles down at the bottom of the cell.

Plates.—The actual shape of the plates is a matter which calls for too much difference of opinion to standardise, but the thickness of the plates can be agreed upon, and the minimum weight in pounds per ampere-hour capacity at a definite rating can be fixed in consultation with the battery makers. It might also be possible to agree upon a range of standard widths together with certain other details.

The quality of the electrolyte is at present met by the expression "suitable for use in storage batteries." A specification might be drawn up by a Standards Committee.

One of the most important improvements in modern storage battery practice is without doubt the practical adaptation of wood diaphragm separators. They cannot be standardised in detail owing to the various patents covering their manufacture and treatment.

In regard to boxes the combination of cheap timber and expensive paint will give better results than expensive timber and cheap paints. This question of a protective paint is of far greater importance than engineers appear to realise. The paint should be heavy bodied, acid-proof and non-evaporative.

(b) Specifications.

The author gives a table compiled from specifications issued during the past five years to show the wide variation in specified points, almost all of which might very well be standardised. There is some information to which everyone will agree; for instance, the number of cells for a given 'bus-bar voltage; the final voltage per cell at any given rate of discharge; the percentage capacity at various ratings taking the 5-hour rate as 100 per cent.; the ampere-hour efficiency of the battery; the watt-hour efficiency of the battery; the normal and maximum charging rates expressed as a percentage of the 5-hour capacity; the maximum difference of potential attained by the battery on charge. Add to these the points open to standardisation in battery design and an equitable method of testing, and the battery specification emerges as a tangible technical proposal instead of a collection of irrelevant and inconsistent stipulations.

Should the author's proposals *re* standardisation be taken up and put into concrete form he advocates that the specification be revised at least every three years.

(c) Tests.

The absence of official standard tests is felt acutely. Merely to discharge a battery for a given number of hours and be satisfied with the result if the final voltage is not below a guaranteed minimum, is crude and non-technical.

Methods employed for testing the efficiency of a battery vary between exactly opposite extremes. Some engineers require the battery to be fully charged, then fully discharged, and again fully charged, the efficiency being calculated from the ratio of the discharge to the recharge expressed as a watt hour efficiency. Other engineers require the battery to be fully discharged, then re-charged, and again discharged, the efficiency being taken as the ratio of the second discharge to the preceding charge, expressed as a watt-hour percentage. The latter appears to be the more reasonable and practical method with certain provisions.

It is unnecessary to stipulate a standard method of testing for all batteries, but alternative methods might be standardised, and the particular one selected by the engineer should be specified. For instance, one satisfactory method of testing is to discharge the cells at a specified rate to a fixed final difference of potential, then to recharge the cells to an extent equal to 10 per cent. more than the number of ampere-hours discharged, and then to repeat the discharge. This will give the effective capacity and efficiency of the cells on the particular cycle and will demonstrate the percentage margin of capacity possessed by the cells over their guaranteed output.

Another method is to discharge the battery at a specific rate of discharge to the guaranteed output, and if the voltage across the battery terminals does not fall below the prescribed limits this will prove that the battery has its guaranteed output. The battery should then be recharged, putting back 10 per cent. more ampere-hours than the guaranteed output, and the discharge should be repeated. The battery will have passed its test if on this second discharge the guaranteed output is again obtained without the voltage across the terminals of the battery falling below the prescribed limit. In this second alternative series the guarantees are demonstrated without consideration of the margin in hand. The author favours this latter method for large batteries.

(f) MAINTENANCE AGREEMENTS.

Maintenance agreements in the past have been to a certain extent a cause of irritation and dissatisfaction mainly because there has been no generally accepted standard, and many engineers have regarded the agreement as an insurance to cover all ill-treatment, bad management, and neglect, in addition to the essential object which is the maintenance of the battery in good working order based on a definite ampere-hour capacity and watt-hour efficiency. If a recognised standard maintenance agreement approved by this Institution were available, negotiations would be greatly simplified.

The conditions which lend themselves to form a non-controversial agreement are quite straightforward and are set out in the original Paper.

HIGH-TENSION BATTERIES.

There has so far been very little experience with batteries working at a line pressure higher than 600 volts in this country. When the Lancashire and Yorkshire Railway decided to employ direct current at 1,200 volts for the electrification of the Manchester–Bury section of their system—a length of 9½ miles—it was necessary to go abroad to study similar schemes. The most instructive—from the battery section—was the electric railway between Stockholm and Saltsjöbaden, a distance of 9½ miles. There the system is a direct-current one at 1,200 volts with overhead conductors, and includes a buffer battery of 650 cells with a rated output of 666 ampere-hours in 1 hour, which represents 800 kw. at the 1-hour rate. The battery is employed for the double purpose of levelling up the line load variations in conjunction with a reversible booster, and also as a capacity battery for lighting and power purposes. The dry Swedish climate tends to simplify the question of insulation.

The Lancashire and Yorkshire electrification scheme offered more difficult problems. The decision to adopt the third rail 1,200 volt direct-current system, coupled with the prevalent humidity of the Lancashire climate, led one to foresee possible trouble through leakage to earth. However, by careful attention to the question of battery insulation, and taking every precaution to prevent the possibility of anyone making an earth connection while in the battery room, the risks have been minimised if not entirely eliminated. There are two battery sub-stations, one at Victoria Station, Manchester, and the other at Radcliffe. Each battery consists of 580 [illegible] Planté cells supplied by the Chloride Electrical Storage Co., Ltd.*

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

STAND-BY BATTERIES.

It is noteworthy that whereas large and even enormous batteries solely for stand-by purposes have been and continue to be installed and form the bulk of central-station battery storage in the United States, no large purely stand-by battery has yet been installed in this country. American engineers claim that developments are bound in time to lead engineers here to adopt the same line of policy.

It is an axiom that a Planté plate must be given fairly constant work or its condition will deteriorate. The Faure or pasted plate on the other hand will endure long periods of idleness without suffering any permanent after-effects. By a fortunate coincidence it is possible to obtain far more capacity for unit weight and cubic contents from a Faure cell than from a Planté cell. A cell of the Faure type is therefore eminently suitable for stand-by purposes. Its durability is inferior to that of Planté cells, but as it is possible to obtain 300 to 500 discharges from one set of plates this should amply cover emergency requirements for a period of 10 years.

An "Exide" pasted plate measuring 15 in. wide × 31 in. high and 7/32 in. thick weighs approximately 25 lb. and has a rating of 166 amperes for one hour. An "Exide" cell with a capacity of 9,000 amperes for one hour measures approximately 5 ft. in length, 21 in. wide, and 5 ft. high.

Normally a stand-by battery floats on the supply system, regulating momentary fluctuations and in readiness for peak and emergency discharging, the adjustment being such that during the floating period the total amount of charge compensates for the discharge. The battery should be floated so that the pressure per cell in circuit will be between 2·10 and 2·14 volts, averaging as near as practicable 2·12 volts.

STAND-BY BATTERIES APPLIED TO ALTERNATING-CURRENT STATIONS.

The installation of a storage battery for stand-by service on an alternating-current circuit presents no insurmountable engineering difficulties, and an interesting example of such an application is found at the Newton sub-station of the Edison Electric Illuminating Co. of Boston (Mass.). In case of any trouble on the high-tension distribution system of sufficient magnitude, the battery takes up all the railway load and feeds back through motor-generator sets into the local alternating-current circuit. In order to ensure constant voltage during emergency discharges, the battery is provided with motor-operated end-cell switches automatically controlled by a contact-making voltmeter connected across the battery terminals.

WORKING RESULTS.

The large batteries at Manchester, Bradford, Birmingham, Wolverhampton, and the sub-stations of the Metropolitan Electric Supply Co., to mention only a few of the large batteries in this country, all show results which prove that the practicability of very [illegible] ing up their specifications. Conditions of working involve various [illegible] entirely for the period of overhaul.

(To be continued.)

Possible Means of Increasing the Carrying Capacity of Underground Cables.—[illegible]

The Commutator Machine as the Standard Single-Phase Type.*

(*Concluded from p. 871.*)

By F. CREEDY.

In the original Paper the author discusses the theory of increasing the speed of such a motor beyond the synchronous speed by applying a higher voltage to the commutator. For variable speed it is desirable to vary both the auxiliary motor winding and the voltage

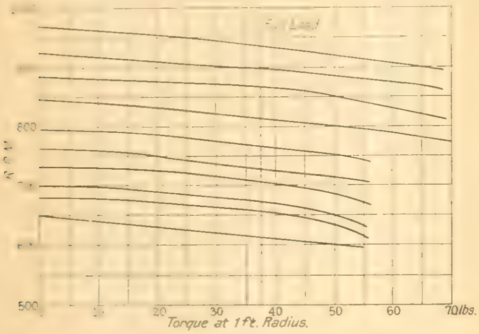

Fig. 3.

from the transformer. In practice only three tappings are provided on the motor winding and six on the transformer. By this means a sufficient number of combinations to give 10 distinct speeds is provided, the field of the motor varying somewhat from the purely

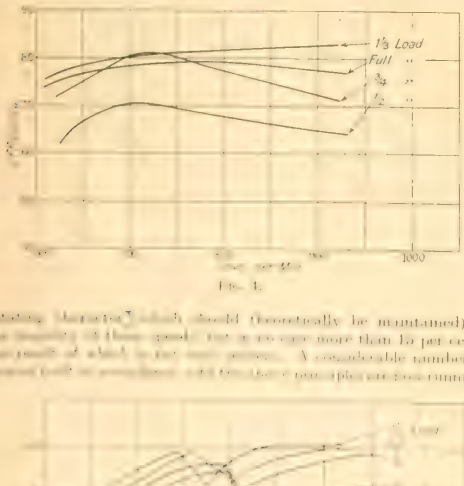

Fig. 4.

[illegible] (which should theoretically be maintained) in the [illegible] more than 15 per cent., [illegible]. A considerable number of [illegible] running

[illegible]

speed. This machine was used for printing press driving, and the curves show clearly the close speed regulation as well as the results obtained as regards power factor and efficiency. It will be seen that the efficiency is practically equal to that of a direct-current motor, while the power factor averages 95 per cent. over the entire range of speed. The curious break in the power factor curve as the machine passes through synchronism (750 revs. per min.) is worth noticing and is rather difficult to account for.

Another special type of motor having a certain field of application is the heavily compounded type used for lift service. Owing to the frequent starting and stopping of the machine it is desirable to make the switchgear of the simplest possible character, eliminating in

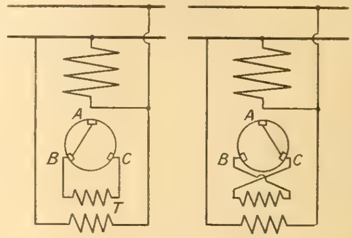

Fig 6.

particular all time lag devices, which, however satisfactory they may be on direct current, seem to give rise to a considerable amount of difficulty on alternating current. The arrangement adopted includes three distinct sets of brushes instead of two, each set being brought out on to one of three independent rockers so as to be capable of a slight relative motion for the purpose of adjusting the starting torque and current. The connections for both directions of running are shown in Fig. 6.

The three brush sets, *A*, *B* and *C*, are normally spaced at equal intervals over two pole pitches, a slight adjustment from this position being permitted with a view to adjusting the starting torque and current. One of the chief uses of this method of adjustment is

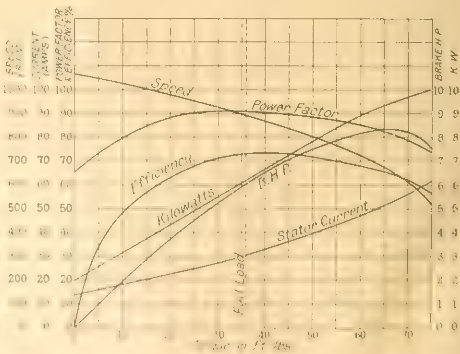

Fig. 7.

found to be as follows. When a lift equipment has been installed a great deal of variation is usually found between one equipment and another, as regards the character of the service it is called upon to give. In some cases it is found that the service is extremely light, and the lift is never called upon to carry heavy loads, in other cases the service is extremely heavy, and loads far beyond the rated [illegible] of the lift are sometimes attempted to be carried. [illegible] adjustment it is possible, after the lift has [illegible] the performance of the motor, so that in [illegible] the current consumption may be cut [illegible], in some cases, it is possible [illegible] powerful torque at the expense

of an increased current consumption. The characteristics of this motor are shown in Fig. 7. It will be seen that the speed torque characteristic is a drooping one, showing a considerable speed variation between no load and full load. There is, nevertheless, a moderate current consumption at starting, equal to about 1½ times full load current, with a torque about 2¼ times full load. The characteristics it will be seen, are equivalent to those of a fairly heavily compounded direct-current motor.

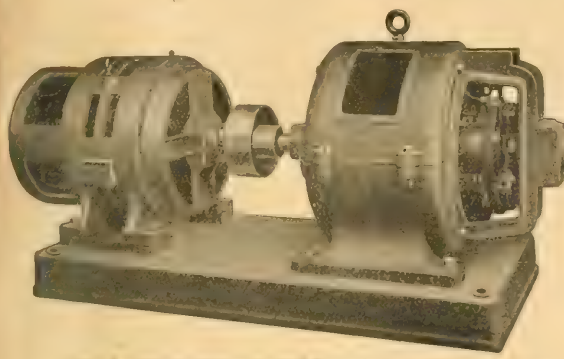

FIG. 8.—MOTOR GENERATOR SET EQUIPPED WITH A SINGLE-PHASE COMMUTATOR MOTOR.

DISCUSSION.

Mr. A. C. BOSTEL said that the induction motor was a tried and trusted machine, but had the disadvantage of low power factor. Some makers guaranteed 80 per cent. power factor with a fine air gap, but this meant close adjustment of bearings, which were, however, always liable to wear. Referring to the Parkinson motor, he thought that the same motor did not always give the same results. Over compounding would set up heat, but this might be due to wattless currents. He had found that the motor had a low insulation resistance.

Mr. E. J. [illegible], speaking of his experience with a 10 H.P. Parkinson motor, referred to the brush adjustment rocker, and said that if this was moved forward, the motor speeded up, and when moved back from the neutral point, the motor immediately ran up to full speed in the reverse direction. With a 20 H.P. motor he had experienced excessive wear on the commutator, and there was also some heating in the transformer leads.

Mr. C. R. BATES said that the real test of a motor was whether it could be sold again to the same consumer. The squirrel-cage machine was cheap in first cost and had a low cost of upkeep. As a contractor he did not feel particularly interested in questions of power factor. [illegible] of motor [illegible] should always include the starter gear. He asked the author for information as to speed control.

Mr. [illegible] asked the author what was the cost of production and selling price of a unity power factor motor compared with an ordinary motor.

Mr. [illegible] did not agree with those who wished to retain the squirrel-cage motor. [illegible]

Mr. [illegible] [illegible]

Mr. A. [illegible] [illegible] would be an advantage if the [illegible]

Mr. W. [illegible] [illegible]

[illegible] pensated type of commutator motor, and that every encouragement should be given to British enterprise in this direction. There had been too great a tendency before the war to purchase anything that was not British. There must be considerable advantages in single-phase commutator motors, because users were willing to pay high prices for the American article.

Mr. F. P[illegible] FLETCHER (Admiralty) said that the report of the Coal Conservation Sub-committee emphasised the need for the extension of motors in industry. He agreed that the English designer was quite as good as the foreigner, and deplored the continued employment of many naturalised designers by manufacturers in this country. The Parkinson motor was a great improvement on account of its large air-gap. It was important to have reliability in motor starting switchgear. Eighty per cent. of the faults on power circuits were traceable to bad starters.

The CHAIRMAN (Mr. J. S. Highfield) said that efficiency should be translated into terms of money. Frequently an exceptionally high efficiency was aimed at, but it had little commercial value.

Mr. F. PARKINSON, speaking as the maker of the Creedy motor, said that there need be no difficulty as to the price of the machine being satisfactory. So far as starting currents were concerned, three-phase motors with star-delta starters quite commonly used two to three times full load current [illegible] cut out. In the Creedy motor, one to 1⅓ times full load current was sufficient for starting. He could not understand the complaints as to low insulation; they were the first that he had had.

Mr. CREEDY, in reply, said that the contractor was now thoroughly familiar with direct-current and polyphase motors, and the difficulties with newer types had to be referred to the makers simply because contractors were not as familiar with these types as with older types. This would become less of a disadvantage as more new type machines were put into service. Replying to Mr. Bates, there was no doubt that this motor could be sold again and again to the same customers. The question of type was, he thought, now narrowed to the compensated and repulsion induction machines. He thought the split-phase machine was so inferior that it need not be considered, except on account of its low price. He did not recommend that large motors should be started with a double-pole switch, because of the heavy currents and the excessively rapid acceleration. Replying to Mr. Warrilow, he was unable to say to how great an extent the Newcastle Electric Supply Co. were influenced by improvements in commutator motors in adopting the policy of changing over from direct current to single phase. He believed that the chief motive of the change over was to shut down the uneconomical small direct-current stations, although, nevertheless, the compensated motor was very carefully tested by this company for use in these cases. The starters used with compensated motors, as pointed out by Mr. Parkinson, were of the standard star delta type, as used with three-phase motors. As to speed control, the dial type of controller was used, and, with the type of motor shown, a speed variation of two to one with 10 intermediate speeds was obtainable, one of the chief advantages of this method of control being that the controller could be placed at any distance from the motor. Replying to Mr. Christmas, he stated that the objection to an excessive amount of apparatus on the wall adjacent to the motor was fully appreciated by the makers, and, having this in view, the latest type of motor, in which there was no transformer, and in which the only auxiliary apparatus required in sizes up to 10 H.P. was the star delta starter.

Mr. POOLEY, supplementing Mr. Creedy's reply, said he was sorry Mr. Creedy in his reply had not dealt with the alleged commutation troubles. [illegible] without sparking or heating, indicated the presence of abrasive dust in [illegible]

Large Generators in the United States. [illegible]

Elementary Principles of Continuous-Current Armature Winding.

By F. M. DENTON, A.C.G.I.

(*Continued from page 875.*)

Summary.—Continuous-current armature windings are first classified, the nature of the various classes of winding is then explained, and special terms used are defined. The derivation of the usual winding rules is developed by a simple method based upon an understanding of the ordinary Gramme ring. The rules derived apply to multiplex windings as well as to simplex. The use of multiplex windings is discussed, and reasons are given for the avoidance of their use. The simple theory of equalising connections is explained and rules are derived for the application of such connections. Chord winding is explained, followed by the use of interpolated commutator segments, and, finally, special consideration is given to the question of the number of slots that should be used for a given winding, taking into account the inductance of the parallel paths. The article concludes with a schedule of winding rules.

EQUALISING CONNECTIONS FOR MULTIPLY RE-ENTRANT WINDINGS.

In multiple re-entrant windings each re-entrant section may be provided with its own equalising connectors, and, in addition, the various re-entrant sections should, whenever it is possible, be put in parallel, independently of the brushes, by aid of permanent copper connectors. This ensures equality of distribution of the load between the various re-entrant sections.

The question of paralleling by aid of equalising connectors the several re-entrant sections of a multiplex winding demands careful thought. The simplest way to parallel the re-entrant sections of, say, a duplex doubly re-entrant winding (O O) would be to remove every alternate insulating plate from the commutator, but this would simply be to change the winding into a simplex. The condition to be aimed at in cross-connecting the sections is that the difference in potential between adjacent commutator segments shall be uniform. This condition may readily be fulfilled in the case of a duplex lap winding in the following way:—The equalising connections are made at the commutator end for the one re-entrant section and at the engine end for the other section, as shown in Fig. 23, which is a developed diagram of a portion of a duplex doubly re-entrant lap winding. If now we start at the segment marked 2, it is [illegible] to traverse two armature bars to arrive at segment [illegible] [illegible] these bars (provided they are about one pole pitch apart) will generate the same E.M.F., and so it follows that the [illegible] in potential between segments [illegible] and [illegible]. [illegible] ought, therefore, to be joined together. This is readily accomplished by [illegible] the [illegible] A and B. All other [illegible] must be similarly dealt with.

In [illegible] the condition of [illegible] of potential [illegible] around the commutator is impossible of [illegible].

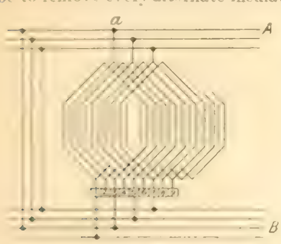

FIG. 23.

[illegible] PARALLEL WINDINGS.

[illegible]

is it correct to call such pairs of segments corresponding pairs. In many cases corresponding pairs of points do not exist. Those accustomed to thinking of alternating-current machines will readily appreciate this point when they reflect that the E.M.F.s generated in the coils of a continuous-current machine are alternating and the E.M.F. between any brush and a given segment are pulsating, whilst the effect of equalising connectors is to parallel with one another various sections of the winding. The condition that such paralleling shall be permissible is not only that the E.M.F.s generated in the various sections shall be equal but also that these shall be in phase and so in synchronism. Thus, in joining what are here called "corresponding points" we should join pairs of points embracing E.M.F.s which are equal and also in synchronism with one another. The E.M.F.s of adjacent re-entrant sections are not always in phase, the E.M.F.s of adjacent armature bars are not in phase, and adjacent commutator segments are not "corresponding points."

Fig. 24 shows a duplex doubly re-entrant (O O) ring winding in which $\frac{Z}{m}\left(=\frac{68}{2}\right)$ is divisible by $\frac{p}{2}(=2)$. In such a winding corresponding positions under all the pole faces are occupied, at a given instant, by bars belonging all to one re-entrant section; hence the various re-entrant sections can never be in phase with one another, there can be no "corresponding points" on the various re-entrant sections, and interconnection of these sections must be avoided.

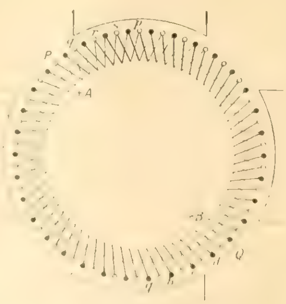

FIG 24.

[illegible] Z/m divisible by $p/2$.

If, for instance, the points p and q were joined by a cross connector, we should have, at the instant shown, the five bars P, q', r, s, p, paralleled, through the cross connector and the brush connector A B with the bars q, b, c, d, Q, with which they are not quite in phase.

The winding of Fig. 24 has no pairs of corresponding points and in such a winding the two re-entrant sections could not be joined without endangering the commutation. This would, of course, apply also to the duplex doubly re-entrant lap winding corresponding to the ring winding of Fig. 24.

More complicated windings may be looked at in a similar way. Fig. 25 shows a four-pole duplex doubly re-entrant ring winding in which the number of bars (66/2) of each re-entrant section has been chosen so that it is not divisible by [illegible]. In this case it is permissible to join such pairs of points as [illegible] [illegible] p and q lie exactly under the middle of a N pole, and p is the same distance from the brush A that q is from B. In this case there is no resultant E.M.F. around the [illegible] P p Q P and no circulating current should flow.

It should, however, be noted that the winding of Fig. 25 is

not suitable for the provision of equalising connections to the individual re-entrant sections, and is, therefore, not a satisfactory winding. Equalising connections in each individual re-entrant section must join points in this section that are exactly a double pole pitch apart, and in Fig. 25 there are no such points available. *Thus it may be seen that in a multiplex ring or lap winding it is necessary to forego either the equalising connectors of the individual re-entrant sections or the inter-connectors between the sections. Either alternative would endanger the commutation.*

The reason that absence of permanent inter-connectors between the re-entrant sections leads to bad commutation appears to be that paralleling of the re-entrant sections solely through the brushes fails to ensure equal distribution of the current between these sections, and that no automatic tendency to re-adjustment exists. In Fig. 24 *Pp* and *Qq* represent sections of two plexes (each belonging to one of the re-entrant sections) parallelled by the brushes. If through some accidental cause the brush contact at *P* should momentarily become bad, this section would take less than its proper share of the current, whilst *Qq* would become overloaded and tend to cause sparking. And since, with carbon brushes, reduction of current brings with it an increase of brush resistance, matters tend not to improve, but rather to get worse. Had it been allowable to permanently inter-connect the two plexes, proper distribution of current would have been assured independently of the brushes.

plexes each plex may be thought of as having allotted to it one particular pair of poles at the centre of the N pole of which its first bar lies. In this way, then, it is readily seen that by joining together bars lying at the centre of each N pole, and any desired number of other such series of points, not only will the separate plexes of each re-entrant section be thus inter-connected but also the several re-entrant sections.

Windings in which p is not divisible by $2m$ have upon their several re-entrant sections no truly corresponding points, and, as a practical compromise, the inter-connection in such cases is brought about by connecting pairs of adjacent segments equally spaced around the commutator.

CHORD WINDING.

As a rule the length y is made about equal to the pole pitch. Windings in which y is greater than the pole pitch are obviously wasteful of copper because of the long end connections and they are otherwise equivalent to those in which y is less than the pole pitch. These are called chord windings. Such windings have the disadvantage of slightly lower E.M.F. than full-pitch windings, for there are moments in each revolution during which both sides of a coil are in one and the same polar region. For a reasonable shortening of the pitch the loss of E.M.F. is but small and chord windings have, on the other hand, the advantage of better commutation than the full-pitch windings.

In a ring winding the coils being commutated at one brush

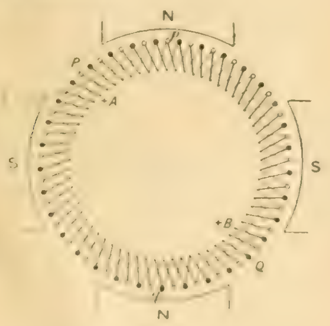

FIG. 25.
[illegible]

FIG. 26.
[illegible]

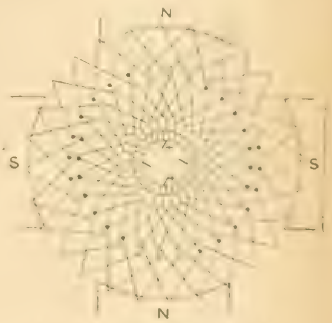

FIG. 27. [illegible]
[illegible]

[illegible] apart.

[illegible]

[illegible]

[illegible]

[illegible] two conductors in which, when the moment for commutation [illegible] tending to prevent the current in A from decreasing. Thus [illegible]

[illegible]

[illegible] alternating-current railway motors leads to improvement in [illegible]

[illegible]

The Overseas Distribution of Engineering Appliances.*

(*Concluded from p. 873.*)

By LEONARD ANDREWS.

Finance.

[illegible] to compute what capital or financial backing [illegible] carry out the overseas engineering trade service proposed, one encounters the difficulty that the engineering industry covers anything from, say, the supply of the smallest electric motor to the equipment of a bulk supply power scheme or the building of a railway. The principal source of revenue, however, would probably be the profits on trading in general engineering merchandise of a kind [illegible] handled by shipping merchants.

Reference has been made to the desirability of procuring the collaboration of shipping merchants in all markets where such merchants have established distributing branches. The co-operating purchasing, and other features of the proposed central control scheme, should greatly increase the previous profits and turnover of these established businesses; on the other hand, their experience, local knowledge and trade connection should be invaluable to the central organisation. It is suggested that, as an inducement to such firms to merge their businesses in the co-operative scheme (whilst retaining local control), they should be guaranteed an annual net profit equivalent to the average net profit during the three years prior to the war, and that they should retain in addition one third of the extra profit earned each year as the result of the larger turnover and other benefits accruing from their amalgamation with the central organisation. The remaining two thirds of the excess profits would be applied towards meeting the expenses of the Central Control Board.

In the original Paper the author considers in detail the cost of 100 distributing centres under the control of a central board. A net loss is shown for the first five years and a net profit over the first 10 years.

It is estimated that the total capital required for trading and working expenses would be approximately one third of the annual turnover; thus, for the above estimated turnover of £8,000,000 per annum, a capital of £2,700,000 would be required. It is suggested that this capital should be raised by public subscription for bonds, the interest and repayment of which should be guaranteed by the State.

It now remains to consider what would be the procedure if some such general scheme of production, co-ordination and distribution, as is recommended, was adopted as a means of improving overseas trade.

It is suggested that the Area Boards of Management should at once confer with manufacturers in their respective districts with a view to ascertaining what standard British made engineering products would be likely to find the most ready sale in overseas territories. Every manufacturer would naturally advocate the inclusion of his own particular specialities. It is, however, imperative that a start should be made with a very limited assortment of types of products, and that the entire selling force should be concentrated upon testing [illegible] The Area Boards of Management would therefore be required to exercise great discrimination in making [illegible] The recommendations of the respective Area Boards of Management would be submitted to the [illegible] would be guided in making their final [illegible] partly by the [illegible] of the Board of Trade and Shipping [illegible] the Central Board and partly by the [illegible] from the Area Boards of Management. When the selection [illegible] &c., [illegible] upon, the Area Boards of Management would [illegible] from all [illegible] and [illegible] sent to the Central Board, whose executive officers would dissect it [illegible]

Customs charges, would be all tabulated and shown as separate items to facilitate rapid adjustment to correspond to changing freight charges.

Immediately upon the termination of the war, the Central Board would make the necessary arrangements for the establishment of distributing centres in every overseas industrial centre, utilising existing selling organisations where possible. The price lists already prepared with sufficient technical data would be forwarded to the general manager of each distributing centre, and the respective estimating departments would prepare local price lists in the coinage of the country, embodying any necessary local charges, margins for discounts, &c., respecting which the central executive would have no knowledge. These local price lists would be freely distributed, together with the British standard specifications available, amongst all potential buyers, and would provide material to enable distribution salesmen to commence their campaign. This would enable the latter to gauge the demand and to report to their respective local centres what sizes and types of apparatus it would be most profitable to stock at the local warehouse. When the Central Board was in a position to place orders, either for stock or to fill direct orders, they would advise the Area Boards of Management of their requirements, and the latter would obtain tenders from all manufacturers in their respective areas. After the orders had been placed, the executive officers of the Area Boards of Management would superintend production and testing, &c., and would take all necessary steps to ensure dispatch according to contract.

DISCUSSION.

Mr. Percy Griffiths, in opening the discussion, remarked that the initiative in any movement of this sort must lie with the trade itself. He protested against the word "control," often used in the Paper, but altered in some cases by the author to "service." Any organisation established in this connection must be for the service, and not the control of the trade. The author said: "The absence of competition between engineering manufacturers has not tended to increase the cost of production of war material," and that "the decentralised system of purchasing engineering products has proved to be a satisfactory method of procuring munitions on an economic basis." The methods that had been applied under extreme stress in regard to munitions would be found to have been anything but satisfactory from the economic point of view. The author suggested some collaboration from the Ministry of Munitions, the Board of Trade and the Foreign Office. If the Government was to exercise any control, it should contribute to the cost. He was a consulting engineer, and was diffident in speaking on this subject, but he must suggest that this scheme appeared somewhat complex and unwieldy, particularly in regard to the gulf shown between the individual manufacturers and the consumers or users. In new works especially it was essential to establish a more direct communication between the manufacturer and user, and in work abroad there must be elasticity in regard to details of design, and in some cases in regard to the whole design. In the past we had standardised our manufactures, and endeavoured to force them on the consumer, and manufacturers must be more elastic in meeting the special demands of users, in view of the varying local conditions in foreign and new countries. Some term should be used which would indicate that the "salesmen" must be experts—must be engineers—and know what they were dealing with. The user should have direct access to an expert. A sufficient number of expert engineers should be available in connection with this department proposed by the author; the engineering industry should be divided according to the capacities of these men, and each should understand thoroughly the branch with which he was connected. Instead of consulting engineers practising as at present he looked forward to their becoming in the future trade representatives, not representing individual firms, but sections of the trade which they would thoroughly grasp. The engineer would be paid by the trade, but would be able to go to the customer and say: "I advise you to use one thing here and another there." The trade interests would [illegible] the advantage of the independent advice which the consulting engineer could give, and the consulting engineer, who might otherwise be [illegible], would find a new outlet for his energies and a new source [illegible]

Mr. [illegible] said it should be remembered that our population [illegible] millions, compared with Germany's 70 millions, and the United States 100 millions. We must make some selection, as we could not [illegible] with the sub-head [illegible] the [illegible] of Chambers of Commerce, the [illegible] the Board of Trade, the Engineering [illegible] British Industries and Shipping [illegible] a body. He found such [illegible] and machines which [illegible] for the officials. He [illegible] that if one wanted to buy, say, a turbine, the

[illegible] it should be able to advise as to what was necessary. He should know the charges [illegible], and the troubles [illegible] and experienced, and have the [illegible] knowledge of the subject which was necessary [illegible] the customer.

Mr. [illegible] ATKINSON [illegible] would be [illegible] trade effectively on the lines adopted in the past in the face of such competition as was offered by the Germans and the Americans. He showed on the screen a diagram with the Allgemeine Elektricitäts Gesellschaft in the centre, and all round it companies all over the world (on which the A.E.G. was represented by its own directors or engineers), and these embodied electric supply, trading, banking and merchant companies. One of these, the Deutsche Bank, was practically a representative of the German Government. He also showed a diagram from the Pengeot Report, issued in America in 1913. In the centre were the three principal money concerns in the United States at that time. Branching out from these were railroad concerns, manufacturing and trading concerns, including the General Electric of America and the Westinghouse, and radiating from the same centre were financing, construction and metal producing concerns, and the influence of all these concerns was used to push trade. The Americans had not so far pushed their trade abroad to any great extent by such organisation, but the extent to which they intended to do so was shown by the fact that the Government, which had dissociated many of these controls, had authorised their re-combination for securing overseas trade. Government control to the extent mentioned by Mr. Andrews would, he thought, make it almost impossible in the engineering world to get a consensus of opinion even in favour of discussing the scheme. Engineering people had to be convinced that combination would increase their business.

Mr. A. NEWLANDS remarked that the boards of management organised by James Stevenson for armament work had been successful in producing a very large proportion of the shell made in the country. It was purely a matter of co-ordinated production.

Mr. PERCY ROSLING said if like were compared with like, the British salesman had not much to learn from his competitors. The A.E.G. had British salesmen in Australia, the General Electric Co. of America had an Australian born staff, and the representatives in Australia of four or five German firms (he thought the Union Company) had a British staff. The Germans would be blown out of our colonies if Britons would not help them by selling their goods after the war. The system they required could not be organised by a huge concern like the Post Office. The manufacturer should have his own representative abroad, or small manufacturers might form a combination, not too large, because as the size increased red tape grew as the square of the staff employed.

Mr. SELWYN GRANT thought the root difficulty in organising was the difficulty of distributing expert knowledge to each of the centres, and if it were not available at each centre the manufacturer had to obtain the information he required through a chain which might be fairly long. That was one of the difficulties with such a cumbrous organisation as the Ministry of Munitions.

Mr. J. E. KINGSBURY said the engineering industry had suffered from the [illegible] of Great Britain. The export trade had been largely [illegible] British merchant, and for those articles that had been [illegible] engineering products the British merchant had not the necessary technical knowledge. Direct representation was introduced by our international competitors because [illegible] Mr. Andrews [illegible] sist of two bodies, one to gather information and the other to get the [illegible] department could not be expected to undertake.

[illegible]

merchant turned it down. The same might happen with an open indent it the merchant could not get the article from his own manufacturer. The customer might go to the Chamber of Commerce and find out who made the goods, but he could not get them shipped in bulk except through a shipping agent, and when he got the name of a maker he might not get exactly what he wanted or the price might be too high. There might also be difficulties through small parts being broken. So that the customer was almost compelled to go to any firm that was represented in the colony, and he came to the conclusion that our distributing system was not a good one. The Germans and Americans always seemed to be on the spot, and to supply almost exactly what was wanted.

Capt. R. B. SLACKE said in new countries it was necessary to supply what a farmer wanted, and wait for perhaps two or three years for payment when there was a good harvest. No manufacturer or group of two or three could finance that. Probably Mr. Atkinson's diagrams explained our ill success against the Germans and Americans. He noticed that a committee of eminent financiers had been appointed to consult with the Commercial Intelligence Branch of the Board of Trade. Could not that Institution and the Civils and Mechanicals help with that organisation, and co-ordinate with that new committee and work out a scheme in detail?

Mr. H. ALLCOCK endorsed Mr. Atkinson's remarks to a large extent. The first question after the war would be overseas distribution. Under the old system each manufacturer had his own representative to some particular market. That was wasteful and inefficient. Mr. MacGregor (one of H.M. Trade Commissioners) had told him he had known 18 British representatives of the same trade in one hotel in Hong Kong, and spending 80 per cent. of their time competing with one another. Even if a merchant had the assistance of an expert, the manufacturer was rather shy of that, because the goodwill in that case attached rather to the merchant than the manufacturer. One of the old methods was to set up groups of allied manufacturers, such as engine makers, dynamo makers, cable makers, &c., to exploit a particular market. That broke down because some of the firms found they did not get their share of the business. He thought all the manufacturers in a trade might combine and send out an expert to give advice to buyers, and that the orders should go to a central sales bureau, and be distributed therefrom. He did not agree with the suggestion of State control, but the State should do all it could to broaden and deepen the channels between us and our consumers.

Mr. H. W. BOSWORTH [illegible] that the State was not compelled to make a profit, which resulted in inefficiency. He saw in State control a vision of endless forms and officials, and the paraphernalia with which Government transactions were camouflaged. The collection of orders by a centre, and the subsequent obtaining of quotations, would suit neither the purchaser nor the manufacturer. If manufacture were arranged so that only five or six firms made one article, he thought costs would be reduced, and it would be easy for each such group to co-operate with other allied groups.

Mr. E. J. K[illegible] control, which they all disliked. He suggested that a number of small [illegible] markets, which would enable each firm to concentrate its energies on a [illegible] heavy machinery, overlooked the necessity for finishing off their machi[illegible] would soon have plenty of men.

[illegible]

Output of Large Generating Stations in the United States and Canada. [illegible]

The Electrician.

FRIDAY, APRIL 26th, 1918.

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Electrical Exports After the War.

The expansion of our exports after the war is a matter of deep concern to the electrical as well as to other British industries.

The plethora of orders and the artificial prosperity, due to the lavish expenditure of war loans, are merely temporary, and the necessity for some compensating outlet when the activity of war work has ceased is fully realised. In many branches the home demand, when peace comes, may be inadequate to occupy fully the enlarged factories and equipments, and attention is naturally turned to the export market for the partial absorption of the enhanced future output. Financial experts may insist on the subconscious effect of the two kinds of depreciation in currency—one reflected in the foreign exchanges, and the other in the general rise in home prices—as a powerful incentive to an increase of exports; but to the individual manufacturer the necessity for keeping his works under full load will be a sufficient stimulus to cultivate the export side of his business.

In his Paper before the Institution of Electrical Engineers Mr. LEONARD ANDREWS reviews some of the difficulties likely to be met with by the British manufacturer in the serious exploitation of foreign trade, and he offers some opportune suggestions for enabling the small producer to participate in its benefits.

Before the war British electrical industry abroad was not unworthily nor unprofitably represented by the large "universal provider" types of firm, and some of the small producers, either singly or in groups, had found good openings for their specialities in foreign markets. The larger houses, either independently or with the help of closely affiliated undertakings, will, no doubt, continue to prosecute their foreign trade with success after the war, and will be able to [illegible] for and carry out any order within the province of electrical engineering. Although projects for complete hydro-electric power schemes or railway electrification lie outside the scope of the small manufacturers, [illegible] in supplying the standard appliances and accessories required by power and [illegible] abroad, and in practice its foreign business in the past has been [illegible]

[illegible]

The essential feature of the export as well as the home trade is that it must pay its way. National kinship and sentiment, or national antipathy, may at times furnish powerful motives; but if the final balance-sheet test is unsatisfactory the efforts to develop and retain any particular variety of foreign business cannot achieve permanent success.

Selling expenses are thus of primary importance, and all the more so when the export agency is on a co-operative basis. The figures given by Mr. ANDREWS are hardly encouraging, even when the course of their ultimate improvement is graphically shown in a quasi-scientific hyperbola and straight-line diagram.

There are not many firms in this country that could survive with selling expenses amounting to nearly 20 per cent. on a £50,000 turnover, in the export of any other branch; but this rather unfortunate example does not vitiate the main argument, which is sound enough. In fact, co-operation in selling is practically the only way in which the small trader can approximate to the advantages that naturally pertain to the mammoth business. The law of concentration, as it has been called, is one aspect of the principle that up to a certain point an increase in the scale of operation diminishes the expenses per unit of product. The law is, of course, equally applicable to the ratio of selling expenses to turnover. The more familiar complementary law—the division of labour—implies that every department of a big concern, or each factory in a group should be confined, as far as possible, to the production of a few standardised articles on a large repetitive scale.

In accordance with these principles, if the administrative committee of a co-operative export organisation, intending to handle one or more complete lines of electrical plant, has decided correctly on the allocation of standard types of apparatus to the individual firms, it has already overcome its chief difficulty. Area boards of management and boards of control, identified more or less directly with the State, figure prominently in most schemes for fostering exports; but the average business man, while granting that Government officials, consuls and trade commissioners may be, and are sometimes, helpful, is naturally sceptical as to their sustained zeal and efficiency. He realises that the driving force of any scheme, whether officially controlled or not, has its origin in the desire of the individual to widen his market advantageously. Boards of control, *ad hoc*, he regards (and often with reason) as liable to cause mere obstructive interference instead of intelligent directive assistance. Hence the need for exercising the greatest care that the propulsive energy at the source is not frittered away in channels that only the most confirmed optimist would call devoid of friction.

When the formation of a cartel of small producers ready to deal with a specific category of goods for export has been completed, it will itself be quite capable of determining the nature and amount of its members' outputs. Such cartels are best formed under the ægis of an authoritative organisation, whose powers and responsibilities are recognised and appreciated in its trade, as, for example, the B.E.A.M.A. in the electrical industry. Professional institutions like the Institution of Electrical Engineers cannot be expected to be more than distantly sympathetic.

[illegible] have but little *raison d'être* in schemes of [illegible] unimportant (at least in England) [illegible] to supply a definite class of ex[illegible] common financial interest in the success of the [illegible] qualification for membership of a general [illegible] It cannot be too strongly insisted that [illegible] prosperity of an export project is ultimately

dependent on its satisfying a real and effective, and not an exotic nor sentimental, demand from abroad. It is not sufficient to have a sound plan of campaign, unless the products on offer possess the attributes of suitability of design and quality, and competitive prices. Foreign trade is not influenced by permanent good-will between buyer and seller to the same extent as the home market, and thus the goods must have inherent and outstanding merits, especially in regard to price. The whole question of the healthy development of exports hinges upon the costs of production in the country of origin, and this again is dependent on the wise application of the principle of the division of labour in its widest sense. But whatever the form into which the electrical export system may finally crystallise, we are fully convinced that the British manufacturer will successfully adapt his methods to the prevailing conditions.

The Coal Conservation Report.

DISCUSSION AT NEWCASTLE

The report of the Coal Conservation Sub-committee on Electric Power Supply in Great Britain was discussed last week at a meeting at Newcastle-upon-Tyne under the auspices of the Newcastle section of the Institution of Electrical Engineers, to which members of all technical institutions likely to be interested in the district had received invitations.

Mr. A. H. M[illegible], of M[illegible], chairman of the [illegible] [illegible] arrived at—was that, by adopting them, the country would save a sum [illegible] for its full realisation that legislative action should follow, they must do everything possible to keep the matter dealt with before the public. The economic argument, briefly put, was that at present more than three times as much coal was being used for the production of power as would [illegible] productivity of our manufacturers, and there would be many incidental [illegible]

[illegible] emplated for electrical, chemical and heating [illegible] to be in the nature of red [illegible]

undertaking. There would be special reasons for Government support during the period of [illegible] for providing employment for discharged soldiers and munition workers at good wages until such time as industrial equilibrium was reached, and another the necessity for promoting every increase of productivity, and consequently of the competitive strength of the country.

Mr. [illegible] haustion than those of any other industrial country, not excepting Germany. Various estimates had been made of our resources of coal, varying from 200 to 580 years, which latter figure was given in the report. [illegible] at a price which would enable us to compete with other industrial countries. America [illegible] developed water-power. Our present methods of using fuel were wasteful alike of capital, fuel and labour. If large units were used, it was possible to create very great economies in the amount of fuel required for each horse-power consumed. Turbo-generators of 25,000 H.P. used 25 per [illegible] In the United States [illegible] machines—*i.e.*, roughly 100,000 H.P. in one unit. It was not only the economy possible by large units which enabled power to be supplied more cheaply by centralised power production; it was even more essential to distribute over very large areas to secure the economy from diversity in use. Centralised power production in large generating units over large areas economised capital in first cost of plant and spare plant, and economised fuel by smaller consumption per horse-power possible, by scientific combustion under expert direction and by possibility of choosing most favourable sites for power plant with ample condensing water. If cooling towers had to be used, fuel consumption was increased by about 15 per cent. Let them take the case of the new Dalmarnock station. The present stations took condensing water from a canal. [illegible] would pay the interest on the new works. There was an economy of labour by saving the handling and transport of fuel from the pits to the power plant and in removal of ashes, an economy of labour in [illegible] small, and an economy by the use of automatic coal-handling machinery, [illegible] north-east coast, but also by the rapid centralisation [illegible] 350,000 H.P., with contracts for further [illegible] power, the [illegible] not told whether [illegible]

[illegible] The essentials were: Large generating unit, ample land for industrial development on the site, good transport facilities, proximity [illegible] subject to all other considerations, ample condensing water, security of supply, unified control of generation and distribution, and that the generating station or stations must feed into a common network covering a very large area. These essentials could be secured with advantage by installing one or more of the large units of 25,000, 50,000 or whatever horse-power was adopted at intervals of something like 20 to 30 miles, all feeding into very high voltage ring mains. That would solve the difficulties which were bound to be formidable in the concentration of plants into stations of 200,000 kw. or even 300,000 kw., [illegible] suggested. These difficulties included the difficulty of finding sufficient condensing water at one point for such large plants, the congestion of rail transport facilities for supply of coal and removal of ashes, as well as the supply of raw material and finished products to and from the works on the site dependent on the electric supply, the difficulty of dealing with the enormous mechanical forces produced in the event of a short-circuit in or near large stations of hundreds of thousands of kilowatts capacity. There would be increased security of supply from air raids, bombardment, &c., by scattered units, as against all the plants being on one site even if subdivided in separate buildings, as mentioned in the report. There would also be greater security arising from less congested outgoing cable routes, and transmission losses would be reduced.

Mr. VERNIER (in further contributed remarks) stated that much discussion had taken place on the question of the cost of electrical transmission, and some things had been read into the report which were in no way suggested, such as point to point transmission. In the discussion at Manchester, for example, figures were quoted for transmitting the [illegible] Manchester load, estimated at 100,000 kw., from a Merseyside power station. Without going into the figures, which was not possible without [illegible] more accurately the data on which they were based, but which for electrical transmission certainly appeared greatly exaggerated, certain assumptions were overlooked, such as that the capital cost of the power station would not necessarily be the same whether inside the Manchester area or outside, and the same load factor had been taken for each case. It had to be recognised that, for equal load and diversity [illegible] it was sometimes difficult to make out a good case for point to point electrical transmission compared with more costly generation close [illegible], but that was not the system the report suggested. [illegible] Lancashire area, his idea was on the lines of a high-voltage network mainly connecting Liverpool, Widnes, Warrington, Manchester, Bury, Bolton, Wigan, St. Helens and Liverpool, with cross-country interconnectors between some of those towns. Manchester's present load factor was about 32 per cent., which was much less than one-half [illegible]. Was it reasonable to expect that [illegible] without interconnection with other towns? Where was the possibility of utilising waste sources of [illegible] supplied from within the Manchester [illegible] power would be wasted if [illegible] to connect them up. He [illegible] was uninformed, and there seemed to be a notable lack of understanding of the lines on which [illegible] and in America were [illegible] high voltage mains, he held, contrary to what seemed to be the general idea, that these should not be for the main part overhead. The main transmission should be [illegible], which was [illegible] to think. Over- [illegible] mains and intercon- [illegible] underground [illegible] private enterprise. [illegible] of electrical [illegible] point. He had [illegible] municipal associations which agreed that the present limitations of the area of [illegible] adequate and [illegible] on the part of [illegible]

commercial successes, and, unless the commercial prospects of the scheme could be clearly demonstrated, national expenditure was not justified. He favoured private control of the scheme; but, in any case, it would mean an enormous and very costly organisation as regarded staff, and, as the power stations would be placed at such considerable distances apart he was inclined to think that the working costs and the cost of distribution would probably exceed the cost of working smaller undertakings on commercial lines. An indication should be given as to the terms upon which electrical energy was to be supplied. The present system was unsatisfactory. He saw no reason why, in a large undertaking, a flat rate should not be quoted; the consumer would then know exactly what he had to pay, and discounts could be given varying in proportion to the consumption. The report did not give definite positions for the super-power stations, and it appeared to him that there would be considerable difficulty in obtaining a sufficient supply of condensing water in positions where coal could be readily and cheaply obtained. He regarded as misleading the statement in the report that the Newcastle Electric Supply Co. and its allied companies supplied current at an average price of under ½d. per unit. It was quite true that collieries obtained electric supply for pumping, air compressing and fan driving at a comparatively low rate, but the charges made for the supply to engineering works, shipyards, &c., were very considerably higher, and it was unfair to overcharge one industry to assist another.

Mr. Mountain gave detailed figures of the actual costs of current production in connection with two industries in the Midlands, showing that in the case of the Park Gate Iron & Steel Co. (Ltd.) the total cost per unit worked out at 0·1429d., and in the case of the Devonshire Works at 0·1094d. Surely, he said, one would not argue that concerns like these should be forced to take current from a supply company at a cost of even 0·5d. per unit. He could give a large number of other instances where costs were very similar.

Mr. H. W. CLOTHIER said he could not help thinking that electrical engineers throughout the country were not educated up to what was known of electric power systems in that district. There was a lot of scare as to the scrapping of existing plant. That question would, however, be settled on a business basis. If it were possible to obtain power at a much cheaper rate than one could produce it at, one could afford to scrap the old or less efficient plant. Electrical engineers should be united and keen on the fulfilment of the promise of that report. They should forego all pettiness, even on the question of municipal *v.* company control. We had not got great research institutions, such as they had in America. We knew very well the keenness of American producers. We knew how they, in our colonies, by their smart salesmanship, controls and arrangements with British firms, had tended to engender the notion that if one wanted big electrical plant, high-tension transmission, one must go to America. Even from Sweden and Norway people went through England, not stopping to look round the plant in this country, straight to America for their supplies. We must get ahead, keep ahead, and show to the colonies and the world the initiative of this country.

Capt. A. H. LAWS thought the report was intended mainly as a sort of ventilation of the whole question, and not as a settlement of details. We would have to be careful in case we might go too fast. They did not want anything bad evolved from that report. He hoped we would go on in the old British way, not too conservatively, of course, but not throw overboard everything we had learnt and get ourselves into a mess.

Mr. MARK HALLIDAY followed, giving details of successful utilisation of coke for electrical generation at Tursdale Colliery.

Mr. W. T. MCCALL remarked that he would like to know whether that ½d. per unit averaged by the Newcastle Electric Supply Co. was for the whole of the associated companies, and how much was for bulk supply, because, of course, in the case of bulk supply, they were cutting out the cost of local distribution. He thought the municipalities were a little more enterprising, and could do things (and had done things) rather better than the report gave them credit for. The report supported the company on account of the company's greater keenness. Keenness for what? The company's keenness was for the profit of the company; the keenness of the municipality was for the profit of the municipality. It seemed to him that the better way to have a board which was not a company, but which was national, with, of course, local representatives in each district. The Lancashire and Cheshire Board had already drawn up a scheme for a body which should represent, not the municipalities alone, but all the undertakings in the district. Personally he preferred that to the company method for that particular district; possibly locally it was another matter. As to research, the proposals of the report were very good as far as they went, but the efficiency obtainable was, admittedly, of the order of from 15 to 20 per cent. of the heat energy of the coal. It seemed to him a serious omission that there was no suggestion for earmarking any proportion of the saving for research on present methods. If the heat engine could be cut out of the chain of energy conversion, so that they got their conversion from coal to electricity without using a heat engine at all, they had got from 80 to 85 per cent. of the energy to work with, and it was at least within the bounds of possibility that the saving suggested by the report could be put out of sight by some saving effected by entirely different means from the present. Therefore provision should be made for research.

Mr. J. R. BEARD exhibited several slides illustrative of the work done by the Newcastle Electric Supply Co. Referring to a 25,000 kw. machine contracted in Chicago four years ago by Capt. Laws, he said we had not got a machine of 20,000 kw. in this country. Two large firms in the U.S., taking sets from 20,000 to 45,000 kw., had 35 in commission and 49 under construction. In this country we had none of these sizes in commission. We had eight or nine of 20,000 kw. and a few larger ones under construction.

Sir Robert Hadfield's Presidential Address to the Society of British Gas Industries.

ELECTRIC FURNACES IN STEEL WORKS.

On the 18th inst. Sir Robert Hadfield, F.R.S., delivered an interesting and comprehensive address to the Society of British Gas Industries, in which he dealt with fuels, with the relative values of coal, coke and electricity in heating steel; with metallurgy, education, commercial matters, patents and buildings for the technical societies. Lack of space will not permit us to refer to all these subjects, but the information in regard to the use of electricity at the works of Messrs. Hadfields (Ltd.) is of more than usual interest, and we therefore reproduce some of the figures that are given.

The way in which the consumption has grown is shown by the diagrams, half the consumption of 54½ million units in 1917 being due to electric furnaces. Some of the energy is generated at the works, but most of it is supplied by the Sheffield Corporation, the price being 0·6d. per unit up to September, 1916, and 0·72d. thereafter. In Fig. 2 all the energy is taken at this price.

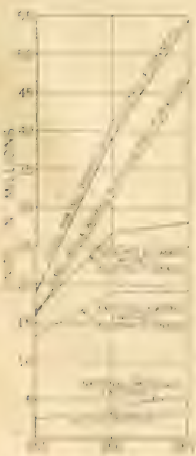

FIG. 1. [illegible]

FIG. 2. [illegible]

[illegible]

Table of Comparison of Coal, Gas and Electricity per Ton of Steel or Iron Heated or Melted.

—	Amount of fuel or energy consumed.	Cost of fuel. Price.	Total cost.	Heat efficiency, %.
Heating 1 Ton of Steel to 900° C.				
Coal heating—		s. d.	s. d.	
(a) Theoretical, 100 % efficiency	0·0182 ton (41 lb.)	20 0 ton	0 4	100
(b) Practical	0·08 ton (179 lb.)	20 0 ton	1 7	23
Gas—				
(a) Theoretical, 100 % efficiency	877 cubic feet	1 4 1,000 ft.	1 2	100
(b) Practical	2,750 cubic feet	1 4 1,000 ft.	3 8	32
Electrical—				
(a) Theoretical, 100 % efficiency	163 units	0·72d. unit	[illegible] 9	100
(b) Practical	300 units	0·72d. unit	18 0	54
Melting 1 Ton of [illegible].				
Hearth—		s. d.	s. d.	
Practical	[illegible]	52 0 ton	7 9	[illegible]
[illegible] 1 Ton [illegible] Steel.				
Crucible—		s. d.	s. d.	
Practical	[illegible] crucible coke	47 0 ton	117 6	[illegible]
Open hearth—				
Practical	[illegible]	[illegible] ton	5 8	[illegible]
Electric furnace—				
Practical	515 units	0·72d. unit	[illegible]	[illegible]
[illegible]				
Practical	780 units	0·72d. unit	[illegible]	47

[illegible]

[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
1 lb. crucible coke	[illegible]
[illegible]	[illegible]

[illegible]

Trade Parliaments and Their Work.

[illegible]

[illegible]

spirit of the war itself, and they will experience a rude awakening when the war does come to an end and they find themselves in a new world brimful of new ideas, new hopes, new standards and new conceptions. It would indeed be little short of a catastrophe if when we have spent the best of our blood and treasure in this great struggle we should be unprepared with plans for reaping the just reward of such sacrifice, and the least that those of us who remain at home can do, in justice to our fighters, is to endeavour so to arrange matters in the old country that when the soldier returns he may truly say that it has been worth fighting for. There are still many people, and I regret to say they exist very largely in the business class, who are hugging the fond delusion that we are going back to the manners and methods of 1914. I beg them to believe that nothing of the kind will happen. Those who had the opportunity of hearing Mr. Ernest Bevin at the inaugural meeting of the I.R.C. at the Guildhall, London, are under no misapprehension on the matter, and they will agree with me that there are only two alternatives now before the business community. Trade, industry, business, commerce—call it what you will—has either to face a revolution on a scale such as we have never experienced before, or there must be a frank acknowledgment on the part of employers as well as employed that it will be carried on in the future with very different ideas from those which have prevailed in the past. Wages and profits, which have hitherto been regarded as the only things that mattered, must be put into their proper place, and each trade must realise that it is a part of the social organism, a part of the national life, and that the nation expects from it that it will take its full share of the burdens which have come to us from the war—that it will, in fact, have to be carried on as a branch of national service, and that labour, management, capital and all parties will have to join together to see that these things are done. Thanks to the growth of trade organisation and the development of the co-operative spirit, these ideals are getting a little nearer. Twenty years ago it was the exception rather than the rule to find two men of a trade who were on speaking terms; to day it is difficult to find a manufacturer who is not working in close association with all his competitors. The same process has been going on in the ranks of labour, until it may be said that the work that remains is surely no more difficult than the work which has been done. If we have succeeded in eliminating most of the follies which kept tradesmen of [illegible] other, surely it should be as easy [illegible] employers and employed in [illegible] stage. The work of the immediate [illegible] the Whitley Report is simply in effect to [illegible] which has now reached a [illegible]

I [illegible] to endeavour to help on that [illegible] way, some of the work [illegible] Trade Parliaments. I shall [illegible] the Whitley Report is accepted by the reader, and that Labour and Capital are joined together in every [illegible] or, as I prefer to call it, [illegible] trade, and I shall en[illegible] these Councils the need for bringing them into being without further delay.

[illegible] trade, and this [illegible] It is, for [illegible] of the [illegible] trade, [illegible] [illegible] Whitley [illegible] [illegible] as such will have [illegible]

Parliamentary Intelligence.

SHROPSHIRE, WORCESTERSHIRE AND STAFFORDSHIRE ELECTRIC POWER BILL.

This Bill was further considered by a House of Lord's Committee last week, and on the 17th inst. Mr. Honoratus Lloyd, K.C., said the promoters were impressed with the absolute necessity of getting the proposed new generating station at Stourport without delay. In order to lighten the Bill and to remove some of the opposition they were willing to withdraw the clauses relating to the manufacture of gas, the treatment of residuals and the production of electricity for chemical purposes.

Mr. David H. Martin, organiser of the Iron and Steel Trade Federation, said important works in the district had been compelled to work short time through inadequate supply of electric power.

Mr. Impey said in his opinion the proposed site of the generating station was the best obtainable.

This closed the case for the promoters, and Mr. Talbot, K.C., addressed their lordships on behalf of the joint opposition. He said his clients had no desire to prevent the development of electric power in the area, but they contended that the promoters were not the proper authority. He contended that if the Committee passed the Bill the area of supply should not extend northward beyond a line drawn from West Bromwich to Rowley Regis.

Mr. J. Hall Ryder gave evidence in opposition, but in cross-examination, he admitted that a further supply of electric power was needed in the district. He had no objection to the scheme provided it were confined to the area south of the line between West Bromwich and Rowley Regis.

Mr. Vesey Knox called several witnesses to bear out his contention that the erection of a generating station on the site suggested would depreciate seriously the value of property in the neighbourhood.

On the 18th inst. Mr. Vesey Knox, K.C., addressed their lordships on behalf of the Rural District of Stourport, in which the promoters propose to erect a new generating station. Stourport was a small industrial town, and they did not claim any general exemption from annoyance, but they contended that they were entitled to the common law protection against nuisance. It was admitted that the erection of this generating station on the site proposed would inevitably cause some annoyance and nuisance. Nevertheless, except in one instance, the company asked to be allowed to put up those works without paying any compensation whatever. His clients asked that there should be inserted in the Bill an extension of the provision contained in the Act of 1906, which authorised the construction of the existing generating station. That clause provided that nothing in the Act should be held to exonerate the company from being indicted for creating a nuisance in carrying on those works in the area. Of the 600 generating stations in this country there were very few which were not subject to that provision.

Mr. Horatius Lloyd, K.C., dissented, and said the provision applied to parochial electric lighting stations, but not to large power generating stations.

The Chairman said the Committee agreed that the promoters should be exempt from the clause in the previous Bill. They also asked for the insertion of a clause providing that nothing in the Act should prejudice any application that might be made during the continuance of the war or for two years after for invocation of the company's powers in Salop and Stafford, excluding Smethwick, and that part of the county of Worcester within the area of the Midland Electric Corpn. for Power Distribution.

The Committee adjourned to enable the clauses with the agreed amendments to be brought up by the promoters.

PONTYPOOL GAS AND WATER BILL.

On Thursday last this Bill, which authorises the promoters to acquire by agreement the undertaking of the Pontypool Electric Light & Power Co. (Ltd.), was passed by a Committee of the House of Lords, presided over by Lord Forteviot. It was announced that terms had been agreed upon by the promoters and the Urban Council who had petitioned against the Bill.

Gloucester Electric Power Bill. Owing to opposition the promoters have decided not to proceed with this Bill.

Private Bill Legislation. The Yorkshire Electric Power and the County of London Electric Supply Bills are now proceeding as unopposed measures. Clauses 3 and 4 of the former Bill have been withdrawn.

Legal Intelligence.

Calderwood v. Coniston Electrolytic Copper Works and Another.

On Monday Mr. Justice Coleridge heard an action brought by John J. Calderwood, [illegible], against the Coniston Electrolytic Copper Works (Ltd.) and Raymond Douvreleur for the recovery of £150, being four months' arrears of salary at £450 a year as engineer of a company formed to extract copper from mine dumps by an electrolytic process. The defence was that plaintiff's agreement terminated on Nov. 6, 1916, and that he had been paid his salary up to that date.

Mr. [illegible] Powell, K.C., for plaintiff, said that although the defendant company was registered in England everyone connected with it except the secretary was French. The other defendant (M. Douvreleur) was chairman of directors. The company got a lease of property con-

sisting largely of dumps from old copper mines near Lake Coniston, in Lancashire. It was thought there was enough copper in the dumps to make it worth while to apply an electrolytic process for its extraction. The ordinary process would have been too expensive. The electrolytic process did not, however, prove to be successful, the company got through its money, and the shareholders declined to find more. M. Douvreleur said the thing had better be closed down, but plaintiff suggested some one else might be found to provide the money for another process. Eventually Baron de Cotelin came over from France, inspected the property and expressed his satisfaction, but later intimated he did not intend to take over the property. Plaintiff claimed wages from Nov. 6 till the date in March when Baron de Cotelin sent his intimation.

Mr. LEWIS THOMAS, K.C., in defence, said plaintiff's continuance after Nov. 6 was conditional upon Baron de Cotelin purchasing the mines, which he did not do.

His LORDSHIP entered judgment for plaintiff for £150 as against the company, and for M. Douvreleur as against the plaintiff, the costs to be apportioned by the Taxing Master.

What is Misconduct in a Workman?

[illegible] Borough Council to recover £23 6s. 6d., being the sum he had paid to the [illegible]

[illegible] employ of the electricity department of the Council since 1901, and had [illegible] and rightly or wrongly, Cradick resented it as it undermined his authority in his opinion, and he lost a certain amount of dignity. There was other stoking to do and Cradick told Osborne that as he started the job he had better finish it. Next morning, Mr. Robinson, the Borough electrical engineer, admonished him, and told him that if he liked to [illegible] overlooked. Cradick said he had nothing to apologise for and refused, saying he preferred to leave and did so. The money he was claiming was his superannuation, and was returnable if he had not been guilty of misconduct. Mr. YOUNG (for the Council) said that the whole point [illegible]

[illegible]

Standard Cable Mfg. Co. (Ltd.)– On the petition of the Board of Trade [illegible] Company. It was stated that all the trade claims had been paid with [illegible] company, and was really formed for assisting that company. The [illegible]

Patent Record.

SPECIFICATIONS PUBLISHED.

[illegible]

[illegible]

[illegible] dynamo-electric machines. (13.3.17.) 114,021.

[illegible] (15.3.17.) 114,027.

[illegible] 114,034.

[illegible]

5,112 [illegible] (11.4.17.) 114,054.

5,840 [illegible] (25.4.17.) 114,063.

6,894 MURRAY, T. [illegible]

8,854 B.T.-H. Co. (G.E. Co.) Electric locomotives. (20.6.17.) 114,077.

11,034 [illegible] switches. (31.7.17.) [illegible]

15,393 [illegible] gas. (25.7.17.) (Divided application on 1,315/17.) 114,117.

APPLICATIONS FOR PATENTS.

[illegible]

4,336 & 4,337 B.T.-H. Co. & YOUNG. E[illegible] Norway.)

4,366 CHAILLIEY. Magnetos.

March 13, 1918.

4,404 SHAW. Electric generators.

4,428 HOWARD. Control of electric furnaces.

[illegible]

4,553 IGRANIC ELECTRIC CO. (Cutler-H[illegible]) [illegible] current motors.

4,556 MORSE. Signalling and navigation [illegible]

March 15, 1918.

[illegible] observation stations.

[illegible] (16.3.17. U.S.)

[illegible]

March 16, 1918.

[illegible]

Volunteer Notices.

LONDON ARMY TROOPS COMPANIES VOLUNTEER ENGINEERS.

[illegible]

Commercial Topics.

Post-War Trade Policy.

We understand that the final report of Lord Balfour's Committee on after-war trade problems will be published in a few days.

It is understood that the committee have followed up their declaration in an interim report in favour of Imperial preference by recommending the Government to take the necessary fiscal measure for the protection of key and nascent industries. A vigorous anti-dumping policy is also strongly supported by the committee. A general tariff on manufactured articles was rejected by the majority, but is recommended in a minority report. The main report also deals with many subjects of special concern to the business community, such as our commercial treaties, trade combinations, the future of shipping, and industrial research. The committee has pronounced against the adoption of the metric system in this country.

* * * *

Electricity Supply and After-War Industries.

At the recent annual general meeting of the Association of Chambers of Commerce the following resolution was passed unanimously:

This Association, recognising the urgent necessity to increase the productivity of our industries after the war as the chief means to meet the burden of the war debt of the nation, and to maintain high wages for the [illegible], urge His Majesty's Government:

(*a*) To recognise that the public supply of electrical energy for power, light, traction, heat, electro-chemical and other purposes, is a key industry insomuch that all other industries are becoming increasingly dependent upon it; (*b*) to hasten the amendment of the legislation which has hitherto hampered its efficient development; (*c*) to ensure the supply at the earliest possible date of ample and cheap electricity for all purposes; (*d*) to conserve our coal resources, the chief wealth of [illegible] the exercise of the maximum possible economy in its use for industrial, domestic and all other purposes.

* * * *

Overseas Trade.

The following have been appointed to serve as a Committee to advise the Department of Overseas Trade on matters relating to its activities:—

Sir Francis Barker (representing Federation of British Industries), Sir Algernon Firth, Bart. (Association of Chambers of Commerce of United Kingdom), Mr. W. H. N. Goschen, Mr. W. L. Hitchens, Lord Inchcape, G.C.M.G., Mr. Walter Leaf, Mr. Kenneth Lee, Mr. G. A. Moore, Mr. J. W. Murray, Sir Geo. Riddell, Bart., Mr. C. V. Sale Capt. Albert Smith, M.P., and Col. Frank H. Wedgwood.

* * * *

Canadian Metal Industries.

[illegible] the Imperial Munitions Board, [illegible] refined spelter [illegible] in the output [illegible].

[illegible] the local production [illegible] of brass to be [illegible] of the orders [illegible].

Electrical Machinery for India.

[illegible] it is stated that [illegible]

* * * *

Cornwall Mining Research.

[illegible]

fund has been secured from the tin mining industry and landowners of Cornwall and from the Research Department, under the control of a Tin and Tungsten Research Board appointed by the Committee of the Privy Council. The balance of the fund held by the institution has been transferred to the new Board.

* * * *

New Industries and Electric Power.

The Executive Council of the Edinburgh Society for the Promotion of Trade is urging the City Council to consider the expediency of obtaining statutory powers to enable it to give preferential terms in regard to rating, the supply of electric power, &c., to the founders of new industries within the city limits.

Electricity Supply.

Extensions.

Aylesbury. The extensions of the electricity generating plant, which include a 200 kw. gas-driven generating set, were formally inaugurated on the 4th inst.

Barrow-in-Furness.—The Corporation has applied to the L.G. Board for sanction to borrow £22,800 for electric supply extensions.

Bradford. The Corporation is recommended to apply for sanction to a loan of £152,651 for a 15,000 kw. turbo-generator, condensing plant and coal conveyor.

Hackney (London).—On Tuesday the L.C.C. decided, on the recommendation of its Finance Committee, to grant Hackney Borough Council authority to borrow a sum not exceeding £58,000 for its electricity undertaking.

The Council asked for power to borrow £68,000, including £40,000 for a 6,000 kw. turbo-alternator and auxiliary plant, and £28,000 for two boilers and auxiliary plant. The balance of £10,000 is to be dealt with when further information as to the probable expenditure is available.

Keighley.—At the meeting of the Council on Tuesday it was resolved to purchase about 21,250 sq. yds. of land at 2s. 9d. per yard for the electricity department.

King's Lynn.—An extension of the plant at the generating station is under consideration.

A new cable is to be laid to provide an additional supply of electric power to a firm in South Lynn.

Stepney (London).—The L.C.C. has sanctioned a loan of £16,680 to the Borough Council on account of expenditure on boilers, plant and machinery for the electricity undertaking.

Reporting on this application the Finance Committee pointed out that the Council has from time to time sanctioned amounts on account of large applications by the Borough Council. The total expenditure involved is £189,330, in respect of which loans amounting to £172,650 have already been sanctioned.

Todmorden. The Council are to consider a proposal to put down modern plant at the electricity works.

General.

Bootle. On Monday the Council approved of the agreement with Liverpool Corporation for the inter-linking of the two electricity undertakings, and for a bulk supply of electrical energy by Liverpool Corporation to Bootle.

Bristol. The Corporation has adopted a recommendation of the Sanitary Committee to abstain from lighting the whole of the public street lamps, whether arc lamps or otherwise, from May 15 to Aug. 13.

Bury (Lancs.).—It has been decided to adopt electric pumping at the sewage works.

Cork. Mr. J. P. Tierney has prepared a report on the condition of the local electricity works and on the proposal to municipalise the undertaking.

Electricity in Shipbuildirg.—At the recent meting of Irvine's Shipbuilding & Dry Docks Co. (Ltd.), Viscount Furness stated that with the object of bringing their plant into the highest possible state of efficiency, and so that the available labour might be utilised to the greatest advantage they were arranging to instal the plant necessary to drive the whole of the machinery at their Harbour Yard by electricity.

Municipal Electric Supply Organisation in Scotland.—At a conference of municipal electric supply undertakings in Scotland, which was held in Edinburgh last week, it was resolved to form an association representative of Scottish municipal electrical undertakings, and a committee was appointed to draft a constitution to consider [illegible] affecting the association and to report.

Newcastle-on-Tyre Electric Supply. An interesting report on the [illegible] of the proposed national electricity supply scheme has been prepared by Mr. Ernest Hatton, engineer and manager of the Corporation tramways.

The report advises that the subject should be dealt with more on the lines of evolution than revolution. It is pointed out that no body of men has done so much to save coal as the engineers of electric power stations. That there were considerable economies to be made in the use of coal was borne out by certain action which the Coal Controller was about to take. Municipalities must see that the proposals in the report of the Committee on national electricity supply are not carried into effect and have their concerns taken from them. The necessities of a community must ultimately be controlled by that community, even if they are not so to-day, and that in the light of increased knowledge, they should assuredly control them in the future.

Provisional Order Applications.—The Board of Trade have declined to grant the application of Crompton & Royton Urban Councils for provisional orders and the Councils as well as Oldham Corporation, which had agreed to give a supply of electricity in bulk in the district, have joined in protesting against the decision.

The Urban Council of Braintree has also been informed by the Board of Trade that until reports from two Parliamentary Committees were known the application for provisional orders for Braintree could not be proceeded with.

St. Pancras (London).—The Borough Council has been requested by the Board of Trade to furnish fortnightly statements showing the total quantity of electricity generated and consumed.

Stepney (London).—As the Electricity Supply Committee considered it desirable that Mr. Tapper borough electrical engineer and manager, should devote the whole of his time to the Council's electricity undertaking, notice for the termination of his appointment to assist the Coal Controller has been given. The Coal Controller has written expressing his appreciation of the valuable services rendered to him by Mr. Tapper.

Waste of Electrical Energy.—At Woolwich Police Court last week Wm. [illegible] was fined £5 under the recent Lighting, Heating and Power Order for causing electric current to be consumed at a local cinema during prohibited hours.

Wednesbury.—The Corporation notifies that it has applied to the Board of Trade for a provisional order to empower it to sell the undertaking of the Corporation authorised by the Wednesbury Electric Lighting Order of 1899, to the Midland Electric Corpn. for Power Distribution, Ltd.

Worcester.—A fourth retort Erith Riley stoker is to be installed at a cost of £720.

Electric Traction.

Belfast. [illegible]

Birmingham. The Tramways Committee has decided not to run tramcars from the central termini after 11 p.m.

Bradford. [illegible]

[illegible]

Doncaster. [illegible]

Halifax Tramcar as Travelling Kitchen. [illegible]

[illegible]

Hull. [illegible]

[illegible]

Leeds. [illegible]

Metropolitan Association of Electric Tramways Managers. [illegible]

Nottingham.—There was a discussion on the revised tramway fares, the condition of the track, &c., at the recent meeting of the Corporation.

The Chairman of the Tramways Committee said that all suggestions had been considered and they would notice that they had reverted to many of the old stages. The Committee was faced with a vastly increased expenditure, amounting to many thousands a year. After careful consideration the Committee decided to drop the raised fares as suggested, and to bring back the old stages. The reason why many of the stages were knocked out was owing to an application from the Government that they should effect an economy in the use of paper.

It would be of interest to know that for two years they had had £25,000 worth of goods on order, but not a pennyworth had been delivered. The Government had forbidden even the steel rails to be rolled. The committee were doing their best to keep the undertaking going, and if the war ended to-morrow they would have to spend no less than £150,000 on necessary reconstruction work. For two years they had been unable to tackle the matter seriously, and practically no material for renewals or repairs had been delivered. He did not think he was divulging any secret in stating that if the war continued for any length of time the whole of the tramway undertakings in the country would be reduced. He attended a meeting in London a short time ago and learned that it was the intention of the Government to close three undertakings entirely, and to reduce as far as possible the number of cars on others.

Transport Economies.—An order has been issued by the Board of Trade that south of a line drawn from the Wash to the Bristol Channel tramway undertakings must reduce their coal consumption by 15 per cent.

[illegible] suggested that in industrial areas owners of factories and business [illegible]

On the group of railways controlled by the Underground Electric Railways Co. of London the train services are to be reduced during the slack hours. Certain stations will be closed down and stops will be made at other stations only during the busy hours.

Imperial Notes.

Australasia.—The Victorian Railways Commissioners have sent to the Minister of Railways a memorandum relating to statements recently made in Parliament respecting their attitude towards the suburban tramways.

[illegible] Tramway Trust to charge fares between Melbourne and Hawthorn, which it is alleged were framed with a view to aggressive competition with the railways. The Commissioners consider that in opposing the construction of the section of the line between Melbourne and Hawthorn [illegible] railways. They are strongly of opinion that the suburban railways [illegible] way service is given the construction of tramways should not be permitted [illegible] tramway profits not being ratified by Parliament, they state that they [illegible]

[illegible] deficit of about the same amount is anticipated for the current year. [illegible] the St. Kilda–Brighton electric tramway produced £27,919 (increase [illegible]

[illegible]

Canada. [illegible]

[illegible] \$117,945, service building [illegible] \$110,000 [illegible] account of province \$110,000.

The Attorney-General of Ontario, who is also a member of the Hydro-Electric Power Commission, stated recently that the Commission are now spending \$1,800,000 on a wood stave pipe line. It is hoped that the power plant, which is to be built at Chippewa Creek, Ontario, will be completed in 1921. When the plant is completed the wood stave pipe line will be scrapped. The Commission have placed orders for work and material to date to the value of \$1,250,000.

Mr. F. A. Gaby, University-avenue, Toronto, is chief engineer of the Ontario Hydro-Electric Commission.

Canadian Water Power.—A reliable estimate of Canada's water-[illegible]

The first estimate of the kind was published in 1911 by the Commission of Conservation. Since then it has conducted water power surveys of British Columbia, Alberta, Saskatchewan and Manitoba, and has secured additional data on the powers in other provinces and it now submits the following figures as being the latest available: Ontario, total possible horse-power 5,800,000, developed horse-power 760,000; Quebec, possible [illegible] 640,000; Nova Scotia 100,000, total [illegible]ed 26,000; New Brunswick 300,000, developed 15,000; Prince [illegible] Island 3,000, developed 500; the total possible horse-power of [illegible]ba, Saskatchewan, Alberta and North-West territories is estimated at 3,500,000, total developed in Manitoba 76,000, Alberta 33,000, [illegible] British Columbia 3,000,000 possible and 250,000 developed, Yukon 100,000 possible and 12,700 developed. [illegible] 18,803,000 [illegible] 1,813,210. [illegible]

Electricity in Mining.—[illegible] "Mining World" the [illegible] spent £150,000,000 on stores [illegible] purchase electricity to the amount [illegible]

Water Power in India.—At the meeting of the Society of Arts on [illegible] the industrial develop[illegible] tremendous supplies of water [illegible] the Bombay Presidency, which could be employed in generating electric power. It would be a good [illegible] complete survey of those and other [illegible] for industrial purposes.

Miscellaneous.

Decimal Coinage.—On Wednesday, Lord Southwark introduced [illegible] House of Lords. [illegible]

Electric Light Switching Examinations.—We regret to learn that, [illegible] Mr. W. Perren Maycock, [illegible] operation, considerable [illegible] Messrs. Landbergs' [illegible] Mr. Perren [illegible] return to normal health.

[illegible]

Tenders Invited and Accepted.

Turbo-Alternator, Boiler, Transformer, Switchgear, Feeder, &c. [illegible]

E.H.T. and L.T. Switchgear. [illegible]

Turbo-alternators, Converter, &c.

PLYMOUTH Corporation require tenders by April 29 for turbo-alternator, converter, transformers and switchgear. Specifications from the Borough Electrical Engineer.

ISLINGTON (London) Lighting Committee require tenders by noon May 24 for (*a*) 5,000 kw. steam turbine, alternator, exciter, condensing plant, switchgear, &c.; and (*b*) water-tube boilers, coal conveyor, telpher, steam piping, &c. Specifications from the Electrical Engineer, Eden-grove, Holloway, N. 7.

WINCHESTER.—The City Council has placed an order with Babcock & Wilcox for the conversion of Nos. 1 and 2 boilers into one unit with a chain grate stoker and a superheater, at £900.

LONDON COUNTY COUNCIL.—An arrangement has been made with Walter Scott (Ltd.) for the supply of 175 tons of track rails at an extra cost over their contract price, and for any further quantity at the same price up to 825 tons, making 1,000 tons in all, which the Council might be permitted to order before March 31, 1919.

The Council has also accepted the following tenders:—

Frodingham Iron & Steel Co., 620 tons of conductor tee rails, at £18. 16s. a ton; Bessemer & Co. and Cammell, Laird & Co., each for the supply of 2,250 driving-wheel tyres, at £3. 11s. 9d. each, and 1,500 pony-wheel tyres, at £3. 2s. 9d. each; Pease & Partners, 500 tons of brake shoes, at £13. 15s. a ton; Western Electric Co., re-heating a further length of about 3,500 yds. of cable, at actual cost, plus 10 per cent.; Midland Electric Wire Co., tramway fittings and equipment, copper-covered wire, &c., £2,515, and British Insulated & Helsby Cables, £4,436.

WOLVERHAMPTON.—The Council has accepted the following tenders:—

Gibbons Bros., iron staircase, &c., for boiler house, £52; J. Spencer (Ltd.), supplying and fixing steam feed and blow-off piping for boiler house extensions, £1,580 plus 10 per cent.; Foster Bros., steam piping for 5,000-kw. turbo-alternator, £145. 18s. 6d.; Ferguson, Pailin & Co., for reactances, £2,868 plus 10 per cent.; A. Reyrolle & Co., alterations to switchboard, £919 plus 10 per cent.; General Electric Co., switch panel for rotary converter, £184; Ferranti, Ltd., meters.

Appointments Vacant and Filled.

Greenock Corporation require a meter inspector and tester, junior draughtsman, fireman, switchboard and sub-station attendants for their electricity department. Applications to the chief engineer and manager, Mr. F. H. Whysall, Electricity Works, Dellingburn-street, Greenock. *See an advertisement.*

An advertiser requires an electrical laboratory assistant for standardisation of instruments and materials and general research work.

A meter test-room assistant is required with good experience. *See advertisement.*

The Newcastle & District Electric Lighting Co., 38, Grainger-street West, Newcastle-on-Tyne, advertise for two experienced switchboard attendants and one wireman.

A shift engineer is wanted for electricity works accustomed to a.c. and d.c. turbines and engines. *See an advertisement.*

Mr. F. J. Harlow has been appointed head of the mathematics and physics department of the Sir John Cass Technical Institute, in succession to Dr. R. S. Willows.

Business Items.

Mr. P. F. Brittain asks us to announce that as Mr. Langdon-Davies has not been connected with the Langdon-Davies Electric Motor Co. for the last 12 years, he has decided to use his own name, as he is sole proprietor of the business. The change to Brittain's Electric Motor Co. will be in *name* only, and all outstanding [illegible] given with machines still hold good. The business will be conducted as heretofore, and the same high standard of excellence [illegible] workmanship, efficiency and durability in this make of motor will be maintained.

[illegible] having been acquired by the Government, Messrs. Berkeley & Young, Ltd., and the New British Electric Supply Co., have removed to temporary premises at Stevenage House, 40 14, Holborn viaduct, London, E.C. 1. The telegraphic [illegible] "Drivewheel, London," but the telephone [illegible] will be altered to Holborn 1150 1.

[illegible] the Electric Street Lighting Apparatus [illegible] London office at 11, Victoria-street, W. [illegible] and all communications to their [illegible] Foundry, Canterbury.

Liquidations, &c.

[illegible] Albert Ernest [illegible] and Wm. Storey, electrical [illegible] 10, Queen Victoria-street, Reading, are to be sent by May 4 to Mr. E. W. J. Savill, 14, Bedford-row, London, W.C.1.

A meeting of creditors of the Electric Lighting & Engineering Co. [illegible] will be held at 13, Castle-street, Liverpool, on May 9.

Companies' Meetings and Reports.

W. T. Henley's Telegraph Works Co. (Ltd.)

The 39th ordinary general meeting was held on Friday, Mr. [illegible] M.I.E.E., chairman and managing director, presiding.

The SECRETARY (Mr. A. E. Salmon) having read the notice convening the meeting,

The CHAIRMAN [illegible] from the [illegible] work done by him for the Company. [illegible] there was an increase of more than £200,000 in the creditors, principally owing to the provision for special taxation, an increased turnover, and, [illegible] little of such stock at home and practically none abroad, and the amount [illegible] material which they had to hold for work in connection with the war. The profit and loss account showed a balance on trading account of [illegible] necessarily large because of the extra provision of machinery for war work and the deterioration due to uninterrupted running. The net [illegible] in the report, carrying forward £112,000, after all reasonable provision [illegible] profits would have been less than they were if there had been no war [illegible] special taxation and the necessity for expenditure on machinery, the use of which after the war was problematical. The volume of trade after [illegible] service of the Government, leaving the amount of payment to cover [illegible] discretion of the Government itself. He repeated that because he wished to emphasise that they were not profiteers in the bad sense of the word. [illegible] of the profits in relation to capital employed was governed by his power to sell. It will be of interest to you to know that the average rate of profit on the turnover was less than that of the two or three years prior to the war. They knew that future taxation must be heavy, and they must suppose that the utmost care would be taken not to make the burden on our industries greater than they can safely carry. Some of them would not grumble if the State took all so-called excess profits during the war, but if after the war a very considerable portion of them [illegible] them to build and equip two factories additional to their original North [illegible]

THE CHAIRMAN [illegible]

resolution proposing to establish a separate entity for their tyre department. Their [illegible] had just informed him that the Treasury had refused its permission to the formation of the Company, but he could not understand that it could have any substantial ground for its refusal. The tyre department had its works separate from their cable factories. They expected to make a great business of the tyre department. They would make an effort to get the refusal of the Treasury set aside, and if [illegible] as if it were another company. He concluded by moving the adoption of the report and balance-sheet.

MR. SYDNEY GEDGE [illegible] unanimously. The retiring directors (Mr. Sydney Gedge and Mr. Robert James Hatton) were re-elected, and the auditors (Messrs. Ball, [illegible] to the directors and staff for their services during the past year.

The CHAIRMAN [illegible] seconded were carried unanimously.

BRITISH ELECTRIC TRANSFORMER CO. (LTD.)—[illegible] report for the year 1917 states that the accounts show, after paying all manufacturing costs and expenses of administration, a net profit of £22,665, and with £5,781 brought forward the available total is £28,446. The board recommend that £7,500 be placed to reserve, £1,500 to depreciation reserve, payment of preference dividend of 6 per cent. for the year (£4,379) and a dividend of 10 per cent. on the ordinary shares (3 per cent. of which was paid as an interim dividend in September last), absorbing £8,749, extra remuneration to directors in accordance with articles of association (£1,067) and that the balance (£5,251) be carried forward.

CONSOLIDATED ELECTRICAL CO. (LTD.)—At the recent meeting it [illegible] general charges were £1,102, and income tax amounted to £1,008. With £3,057 brought forward, the available balance was £6,597. The directors [illegible]

CUBA SUBMARINE TELEGRAPH CO. (LTD.)—The [illegible] 1917 states that receipts were £72,531 and expenses £19,293. After providing £6,567 for cable repairs and £2,702 for income-tax, there remains £43,970 with £7,637 brought forward, the total is £51,607. The directors have added £10,000 to general reserve and £2,500 to pension fund. An interim dividend at rate of 5 per cent. per annum, tax free, has been paid on the ordinary shares, and the directors now recommend a final dividend at the same rate and a bonus of 4s. per share on the ordinary shares, tax free, leaving £21,907 to be carried forward, subject to any claim for excess profits duty.

ELECTRO-BLEACH & BY-PRODUCTS (LTD.)—The profit for 1917, after [illegible] £25,902, against £19,497. After charging interest and sinking fund, and [illegible] further interim dividends (on account of 1917) on the preference shares, making 7 per cent. for the year, and of 10 per cent. on the ordinary [illegible] and £1,670 carried forward, against £1,076.

[illegible] pay off the whole of its preliminary expenses, besides increasing the [illegible] establishment, and any prosperity which the company had achieved [illegible]

JOHNSON & PHILLIPS (LTD.) [illegible]

PARA ELECTRIC RAILWAYS & LIGHTING CO.—[illegible]

[illegible] as compared with £148,288. As the accounts [illegible] rate of 16d. per milreis, there must [illegible] after providing for 4 per cent. dividend on ordinary shares, making 7 per cent. (less tax) for the year, against 6 per cent.; [illegible] fund £20,000, and reserve for contingencies [illegible] £34,009 is carried forward, against £25,572.

MADRAS ELECTRIC TRAMWAYS (1904) (LTD.)—For the year the gross profit was £27,831. After debiting interest and London office expenses, making provision for the debenture stock sinking fund, and transferring £8,000 to depreciation and renewal account, the balance is £13,522. With £4,315 brought forward, the total is £17,837. The dividends on the preference shares absorbed £6,000, and the interim dividend of 4 per cent. on the ordinary shares (paid September last) £2,290, leaving £9,547 0s. 10d. The directors recommend payment of a further dividend of 4 per cent. on the ordinary shares (making 8 per cent. for the year) tax free, which will absorb £2,290, the transfer to general reserve of £3,000, leaving to be carried forward £4,257. The traffic receipts and the expenditure in Madras show an increase of 10·3 and 6·8 per cent. respectively upon 1916.

ROTHESAY TRAMWAYS CO. (LTD.)—The total receipts for the past year were £8,636. After providing for expenses, including £1,907 for debenture and other interest, payments to local authorities (£270), and providing £900 for renewals fund, there is, with £140 brought forward, a balance of £1,223. The directors propose to place £600 to reserve, and to pay a dividend of 5 per cent. on the preference shares, and to carry forward [illegible]

UNITED ALKALI CO. (LTD.)—The report states that, after providing for excess profits duty for 1915 and 1916, and special taxation, transferring £15,000 to debenture redemption fund, the net profit is £196,169. After deducting final dividend on ordinary shares for 1916 at 2s. per share, £23,529 is carried forward. A settlement of questions arising out of the Finance Acts has only been arrived at since Dec. 31 last, and is still [illegible] reservations.

New Companies.

AUTONITERS (LTD.) (149,978.)—Private company. Reg. March 26, [illegible] Mechanical and electrical engineers, iron and [illegible] manufacturers, electro platers. [illegible] First directors are W. J. Harris, J. Duncalf, W. F. Hannay and H. D. Smith. Reg. office: 9, Regent-street, S.W. 1.

AERONAUTICAL ENGINEERING CO. (LTD.) (150,062.)—Private company. Reg. March [illegible] capital £20,000 in £1 shares. Electrical, [illegible] manufacturers, repairers and dealers [illegible]

CHARLES BOOTH & CO. (LTD.) (149,884.)—Private company. [illegible] £22,000 in 20,000 preference shares of £1 each [illegible] Dealers in machinery and tools [illegible] engineers, boiler makers [illegible] Reg. office: [illegible] Park-lane, Liverpool.

GENERAL PNEUMATIC APPLIANCES (LTD.) (149,971.)—Private company. Reg. March 2[illegible] capital £30,000 in £1 shares. Manufacturers, [illegible] pneumatic and electric tools and machinery [illegible]; millwrights, &c., and to enter into an [illegible] P. O. Don [illegible] Reg. office: 14, [illegible] street, W. 1.

J. COLLIS & SONS (LTD.) [illegible] Reg. April [illegible] capital £120,000 [illegible] J. Collis & Sons, [illegible] and general [illegible] K.C.M.G. [illegible]

MACKINNON & THOMAS (LTD.) [illegible]

[illegible] LAMP WORKS (LTD.) [illegible]

PHILLIPS [illegible] (LTD.) [illegible]

[illegible]

SOCIÉTÉ ANONYME DE [illegible] (LTD.) [illegible]

First directors are O. C. Selbach (permanent managing director, American citizen), J. A. Moore, A.M.I.C.E. (British), G. Anzani (Swiss) and A. P. Rosselet (Swiss). Reg. office, 28, Russell-square, W.C.

VALE METAL CO. (LTD.) (149,893.)—Private company. Reg. March 16, capital £1,500 in £1 shares. Smelters, refiners, &c., of minerals and metals, electrical and general engineers, &c. First directors: W. B. C. Dobson and A. J. Henderson. Reg. office: 78, Brighton-road, Surbiton.

WILLIAM COOPER & GOODE (LTD.) (149,836.)—Private company Reg. March 11, capital £50,000 in £1 shares. Metal merchants, brass rollers, manufacturers of and dealers in brass, copper and zinc, wire drawers, &c. First directors are J. A. Kenrick, W. Chamberlain, A. Neville Chamberlian, E. E. Dendy, J. A. Kenrick, F. Platten and T. W. Horton (all permanent). Reg. office, Bradford-street, Birmingham.

City Notes.

INDO-EUROPEAN TELEGRAPH CO. (LTD.)—The directors recommend a final dividend for 1917 of £1 2s. 6d. per share (making 7 per cent. for the year), plus a distribution of £1 10s. per share, both tax free.

LONDON & SUBURBAN TRACTION CO. (LTD.)—A dividend of 2½ per cent. on the preference shares for the year ended Dec. 31 last is recommended.

MONTE VIDEO TELEPHONE CO. (LTD.)—An interim dividend of 6 per cent. per annum (7½d. per share), tax free, has been declared on ordinary shares for half-year.

OLDHAM, ASHTON & HYDE ELECTRIC TRAMWAYS (LTD.)—A final dividend of 3½ per cent. has been declared on the ordinary shares, making 6 per cent. for the year.

SIEMENS BROS. & CO. (LTD.)—Although the accounts have not yet been made up, a dividend of 10 per cent. in respect of the year 1917 has been declared.

SUBMARINE CABLES' TRUST.—Notice is given that 49 certificates will be redeemed by a drawing which will take place on the 1st prox. (at 2.30 p.m.) at the offices of the Trust, 34, Electra House Finsbury-pavement, London, E.C., for payment of £120 per certificate at Messrs. Glyn, Mills & Co., 68, Lombard-street, London, E.C.

The Round Table.

By "kVA."

Bon Mot of the Moment.—"Guilty!" Prince Lichnowsky's "astonisher for the Boche," published in pamphlet form by the National War Aims Committee. Get a copy at any bookstall, read it and pass it on!

* * * *

From a Daily Paper:

"A man hurriedly entered a post office to find an address in the telephone directory, but found a lady studying the book very intently. He waited patiently for a while, but she seemed no nearer the object of her search, and as his time was limited, he finally ventured: "If you are in no great hurry, madam, would you be so kind as to allow me to glance in that book for just a moment?" "Oh, certainly," replied the lady, "I was just looking it over to find a pretty name for baby."

* * * *

A friend of mine who dabbles in ballistics, tells me that the Boche long range gun is fired at a moving target. He contends that by the time the shell reaches Paris the city has moved one mile, due to the earth's rotation, and that allowance is made for this. Now, you artillerists; has it?

* * * *

Over Zealous Youth to Order Clerk: Here is an order for goods from the War Office. Shall I ask for a trade reference!!

* * * *

Thirty-Seven Years Ago.

[From The Electrician, April 23, 1881.]

Electric Light at the Hague.—The land of water, which sounds [illegible] caught the fever. One of the shops at the entrance of the Arcade in the Hague is illuminated by means of the electric light.

[illegible] Palace.—An opportunity is about to be afforded [illegible] the experiment of enlisting electricity as a motive power [illegible] been laid down in the Crystal Palace grounds by the Société Anonyme Electrique de Bruxelles.

L'Electricien.—We have at last received the first number of this long promised paper, and now that it has appeared we do not [illegible] We must confess to having thought that electrical science was sufficiently represented in France by our contemporaries "L'Electricité" and "La Lumière Electrique." We fear that the multiplication of electrical journals, so far from [illegible] the student, will only embarrass and discourage him.